AIR CONDITIONING HEATING AND VENTILATING

MARCH 1961

For the Engineer
Engaged in DESIGN
APPLICATION
ESTIMATING
SPECIFICATION
and LAYOUT

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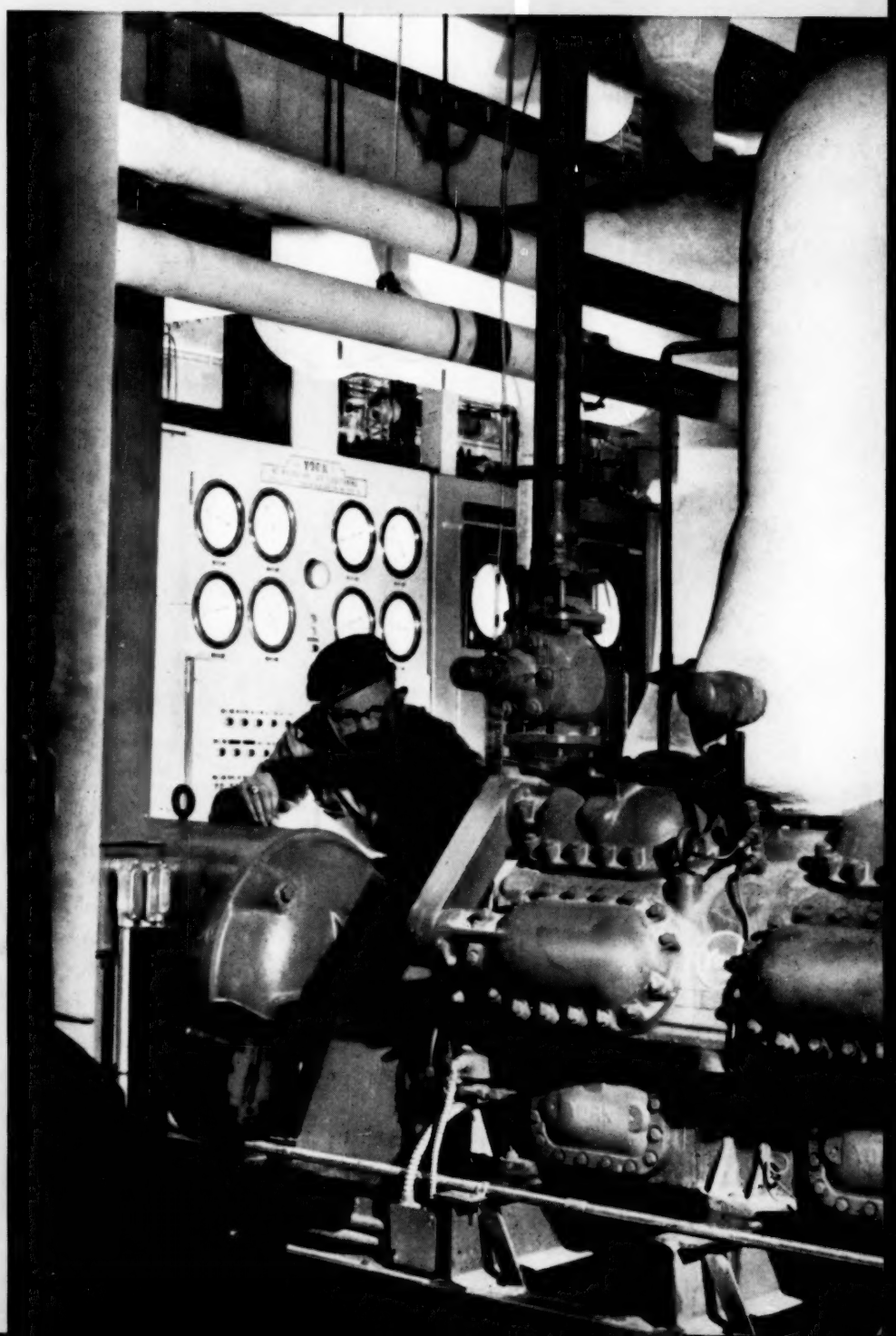

Alexander's Department Store, Rego Park, N. Y., boasts this dual unit, air source heat pump system having a total cooling capacity of 820 tons. Photo, courtesy of York Division, Borg-Warner Corporation.

NO "NEW IMAGE" FOR US, THANKS

Seems nowadays practically everyone talks about "changing the image," "creating a new corporate image" or "giving the product a more dynamic image."

There's no such talk around Jenkins Bros.

When it comes to valves, we're as modern as tomorrow! But when it comes to a new corporate image, no thanks. Not for us. Our corporate image is nearly 100 years old, and it still suits us just fine. Here's why:

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"A Fair Offer" was first published in 1869. Simple and forthright, it said that Jenkins Bros. wanted Jenkins Valves to be judged on performance. But — and this made the difference — not on performance in the average application, but rather in the very toughest one. Note that phrase, "the worst place you can find."

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At intervals we republish "A Fair Offer" just because it does make sense to so many of our customers and friends. It's a useful reminder that products may change but *high standards* never go out of style.

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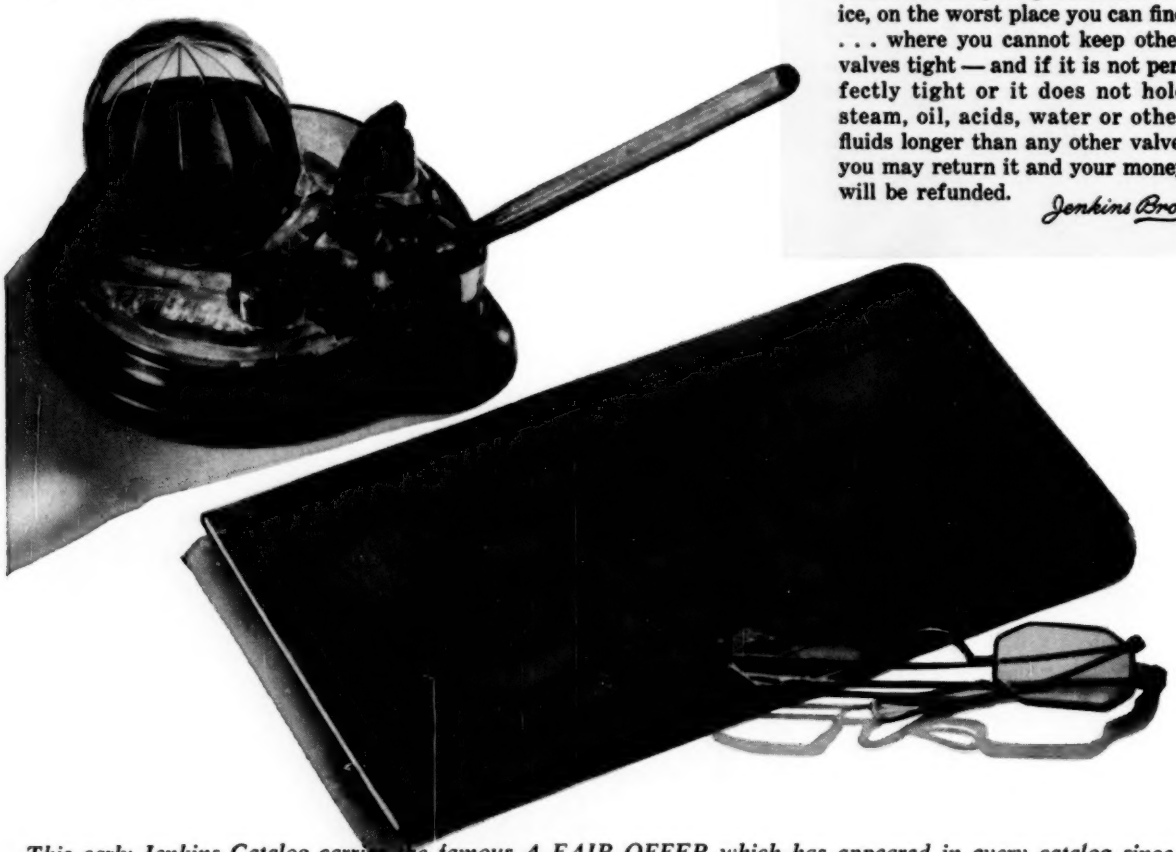
A FAIR OFFER

If you will put a Jenkins Valve, recommended for your particular service, on the worst place you can find . . . where you cannot keep other valves tight — and if it is not perfectly tight or it does not hold steam, oil, acids, water or other fluids longer than any other valve, you may return it and your money will be refunded.

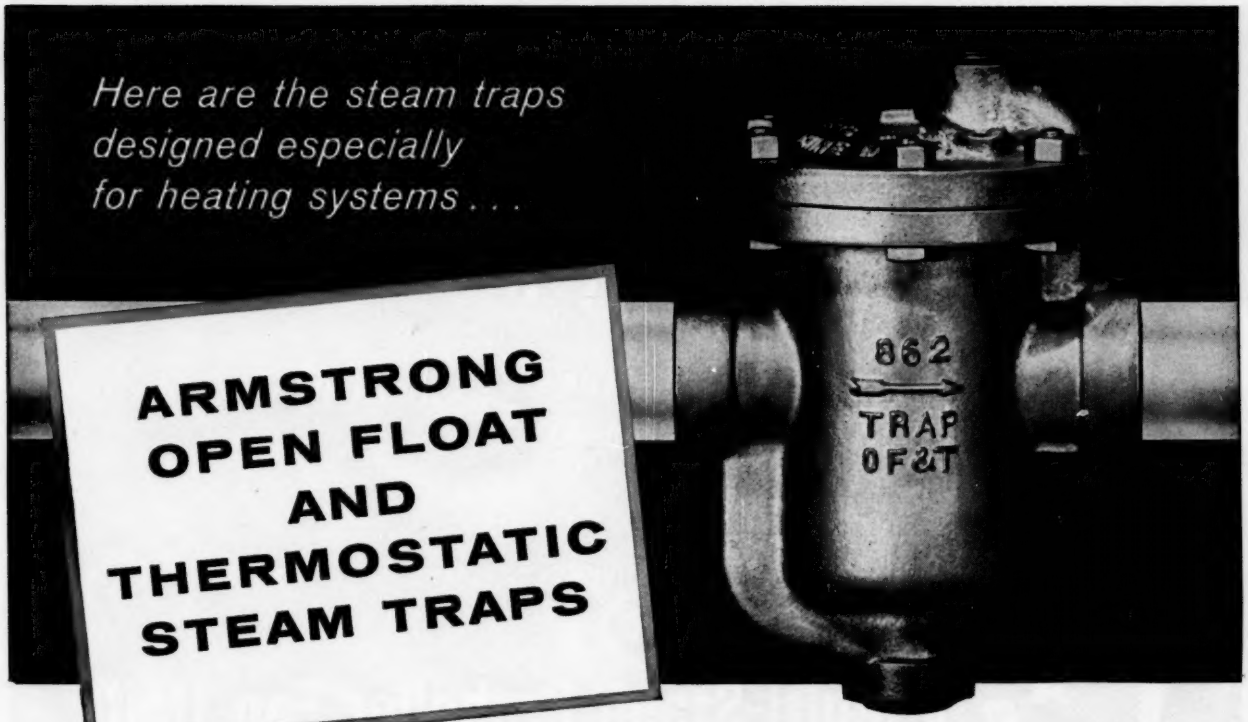
Jenkins Bros



This early Jenkins Catalog carries the famous A FAIR OFFER which has appeared in every catalog since 1869.

For more data circle card at back of book

Here are the steam traps designed especially for heating systems . . .



ARMSTRONG OPEN FLOAT AND THERMOSTATIC STEAM TRAPS

Engineered for low pressure intermittent service where large amounts of air accumulate while steam is off

Armstrong O.F.&T. Traps make it possible for heating systems to deliver the efficiency they were designed to deliver. They are ideal for low pressure unit heaters, preheat and reheat coils, converters, hot water generators, etc.

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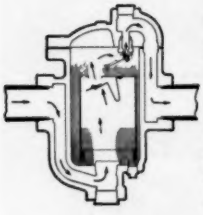
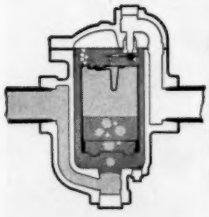
HOW ARMSTRONG O. F. & T. TRAPS WORK:



When steam is turned on, it pushes air through the wide open thermic vent and trap discharge valve at full differential pressure between supply and return lines. Condensate formed by incoming steam goes right through.



As steam reaches open float, thermostatic vent closes. Float fills with steam and rises to close trap valve. Residual air and CO_2 escape through fixed vent at steam temperature.

BULLETIN NO. 775 BULLETIN NO. 801

Use the coupon at right to get these helpful bulletins: No. 775 describes O.F.&T. traps fully. No. 801 tells how to select traps for draining unit heaters including data on 20 makes of unit heaters.

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Please send me: ☐ O.F.&T. Trap Bulletin No. 775; ☐ Unit Heater Bulletin No. 801.

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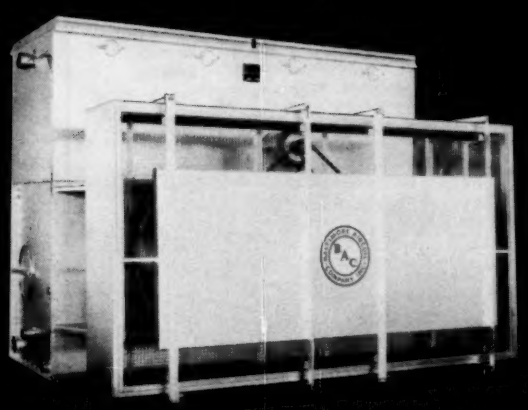

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AIR CONDITIONING HEATING AND VENTILATING

Volume 58, Number 3 **March, 1961**

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INSULATION ECONOMICS: Thirty five years ago L. B. McMillan, at that time chief engineer of Johns-Manville, prepared a paper for ASME entitled "The Economic Thickness of Insulation." This paper became a classic in the pipe insulation field. It is the editors' hope that the **Reference Section** in this issue, **"How Much Building Insulation is Justified?",** by C. C. Thomas, will be similarly received in that it does for building insulation what McMillan's paper did for pipe insulation—namely, show how to determine what amount of building insulation will yield the maximum return on the investment. See page 67.

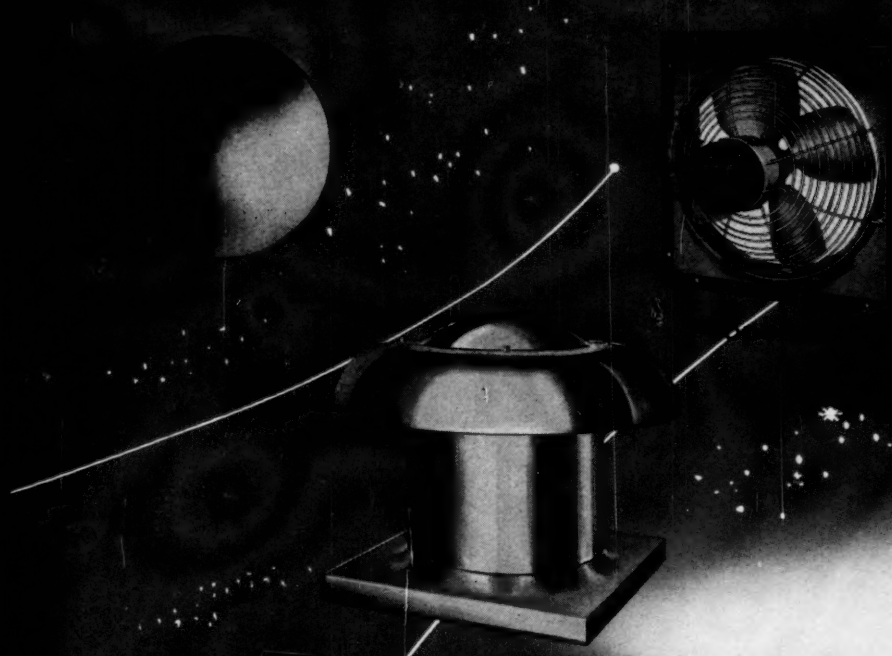
HIGH SPOTS in this issue

KEEPING PRESSURES DOWN: The **pressures in chilled water lines for tall buildings** can easily become excessive unless the system is broken up into hydraulically separate zones. Mr. Daryanani, in this month's lead article, page 53, explains the different ways to do this and the new problems entailed in each solution.

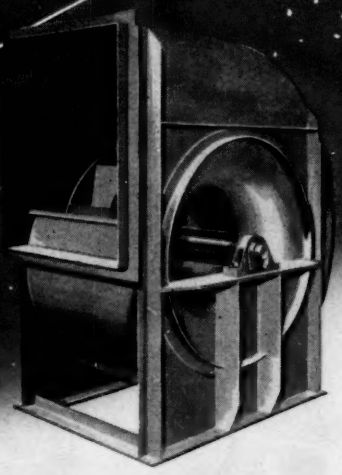
A PRACTICAL APPROACH TO COILS: A direct method for determining capacities of coils which the working engineer can follow is presented by Mr. Ludwig, who has taken the considerable theoretical breakthroughs of the recent period and reduced them to a **step-by-step procedure for determining evaporator capacities.** Page 58.

SCHOOL DESIGN: What is rightfully described as a new approach to school design was proposed recently at a seminar sponsored by the American Gas Association. Following through on a previous meeting which stressed the value of the "compact" school, this seminar reported on research which was undertaken to develop a mechanical and electrical system for such a school which would show savings in annual operating cost. **Heart of the new design is a gas turbine** which would produce power at any frequency desired (400-cycle power was recommended;) exhaust gases, at about 850 deg F, would provide a source of heat for building heating and absorption-type air conditioning. For a full report on this seminar, see "A New Approach to School Design", page 85.

KEEPING VENTILATING COSTS DOWN: In the heating and air conditioning of industrial plants, control of outside air must be carefully designed if costs are to be held within reason. Mr. Porembski has designed an **air mixture chart which greatly simplifies the calculations.** Page 64.



Roof Ventilators



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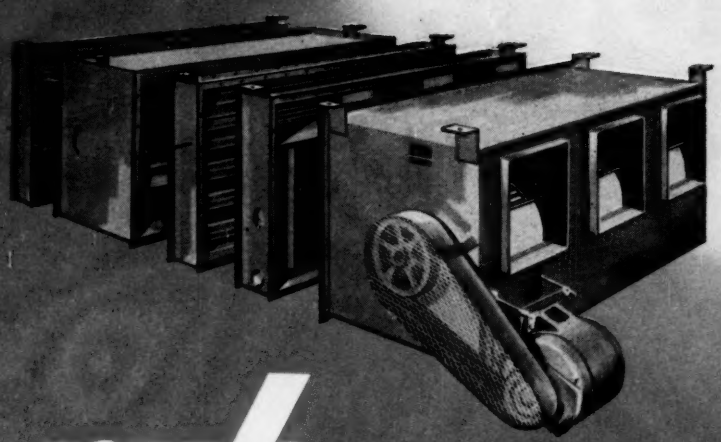
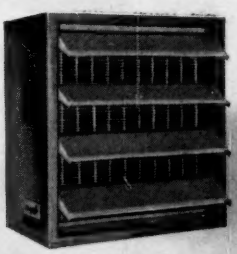
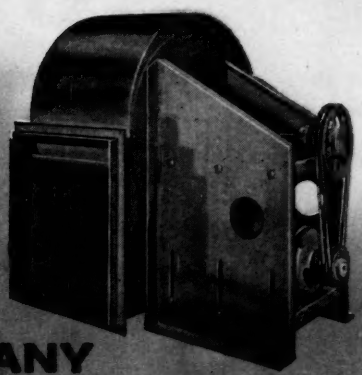


Centrifugal Unit Heaters



Propeller Unit Heaters



General Purpose Fans

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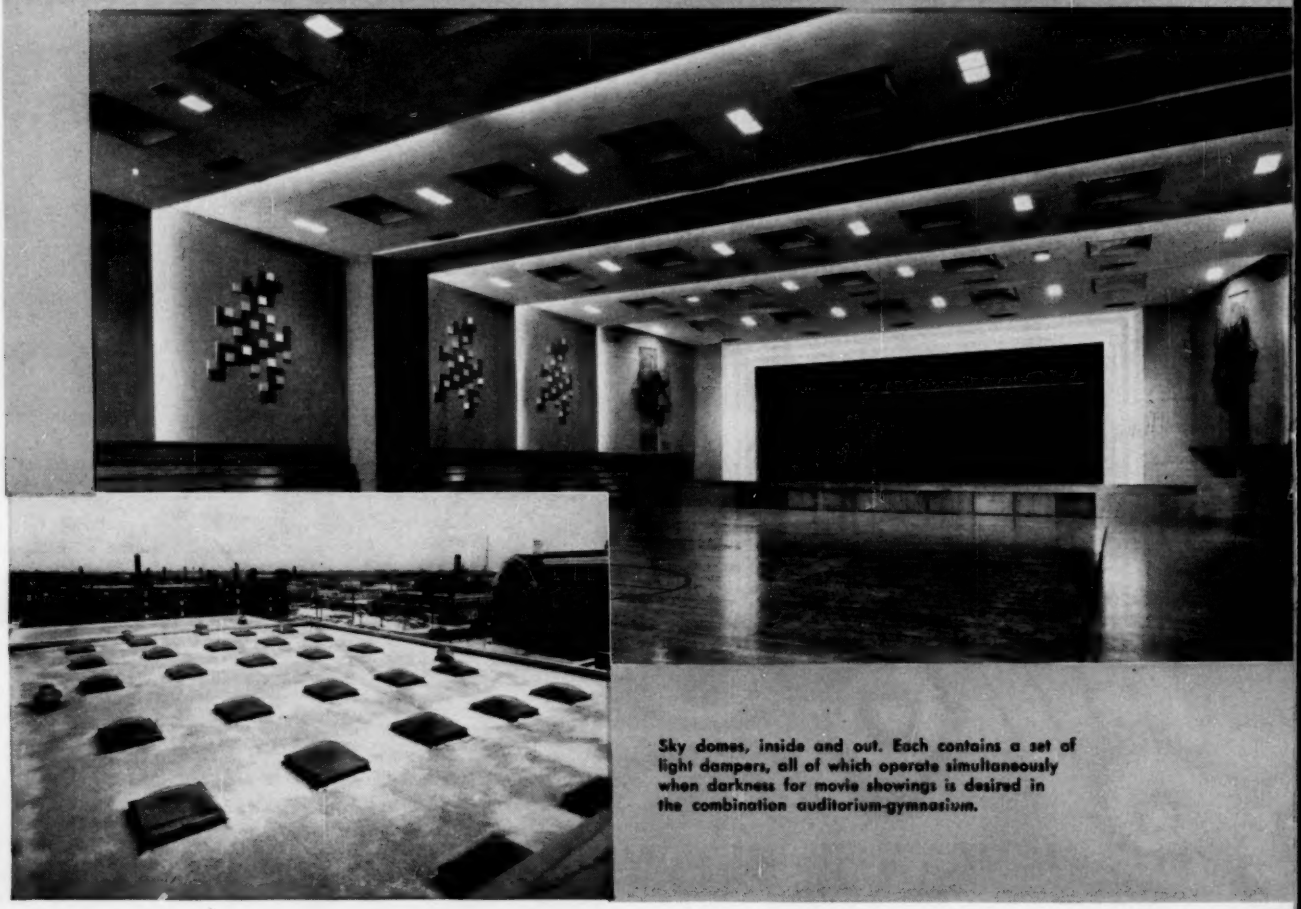
Imaginative Engineering Puts to Work on *DAYLIGHT*

Mike Best and Ed Kralovec, mechanical engineers on the Madonna school, shown discussing job details with two of their colleagues.

Kralovec & Best, consulting engineers, went one step further in their heat and ventilation design for the new Madonna High School, Chicago — they applied pneumatic control to skylight louvers.

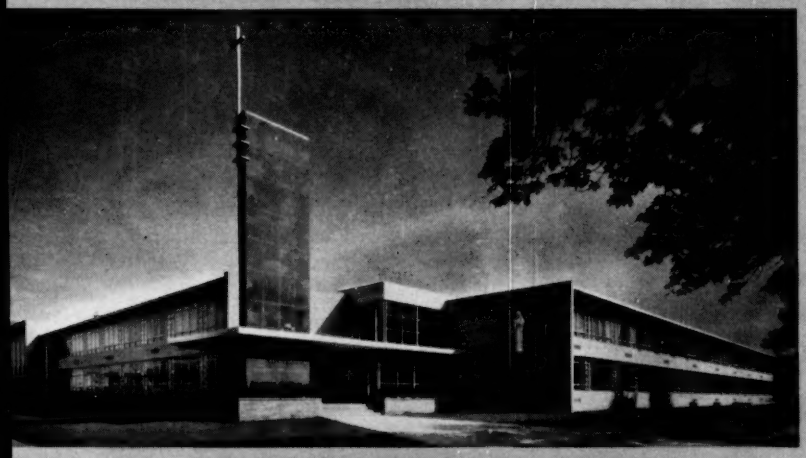
To meet the lighting requirements of the combination auditorium-gymnasium, architect C. I. Krajewski used a system of sky domes equipped with adjustable light dampers. How to control the dampers quickly and efficiently for change-over from plenty of daylight for gym activities to total blackout for movies, etc., was the problem presented to the consulting engineer.

Kralovec & Best's solution was — twenty-nine 4-inch powerstroke piston damper motors — one for each of



Sky domes, inside and out. Each contains a set of light dampers, all of which operate simultaneously when darkness for movie showings is desired in the combination auditorium-gymnasium.

Powers Pneumatic Control



MADONNA HIGH SCHOOL
Chicago, Ill.
Architect: C. I. Krajewski, Chicago
Consulting Engineers:
Kralovec & Best
Chicago
Heating Contractor:
Windsor Heating Co.
Chicago

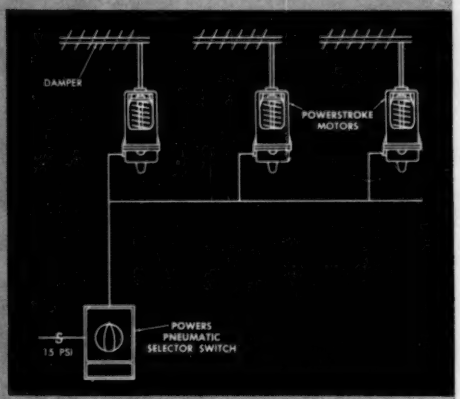
the sky dome louvers on the roof — energized instantly from a single Powers pneumatic selector switch in the projection room. Turning the switch activates air pressure at 15 psi. through a Powers Series 500 Pilot Valve to the motors to close the light louvers. When the switch is turned off, pressure is released . . . and the louvers swing open to admit light.

Pneumatic control of daylight in Madonna school is fast, easy and quiet — a definite convenience for the projectionist or instructors, an operational bargain for the school, maintenance-wise.

The complete heating system, as specified by Kralovec & Best, includes two hot water converters controlled at fixed temperatures. Individual classrooms are heated and ventilated by unit ventilators, controlled on the standard day-night cycle. Corridors, rest rooms, storage and locker rooms employ direct radiation controlled by Powers Day-Night room thermostats. For extra safety and comfort, hot water to all showers is controlled by means of a Powers Hydroguard Thermostatic Shower Control.

Here, then, is how imaginative engineering applied to pneumatic control can have unusual — but practical — results in an efficient, low cost system.

A single pneumatic selector switch in the projection room actuates 29 sets of light louvers through 29 individual powerstroke motors.



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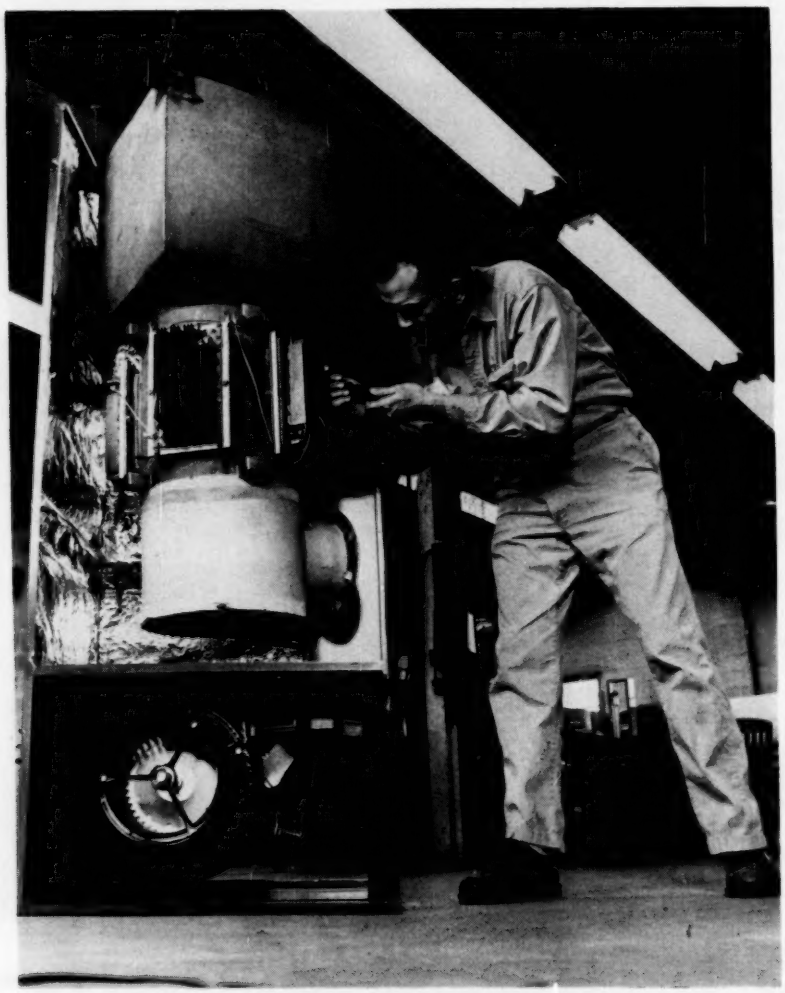
Lists Eight Keys to White-Room Cleanliness Based on Experience with Two Installations

The "human factor" is the basic problem in maintenance of design conditions in white rooms, it was reported. Speaking before the delegates to the 12th Plant Maintenance & Engineering Conference, Robert L. Cash, plant engineer, Semiconductor Components Div., Texas Instruments, Inc., Dallas, outlined eight key principles for assuring room cleanliness, based on his experience with two installations. The first item listed is the restriction of access of humans to and from the area.



A THERMOELECTRIC GENERATOR powers the blower in a new gas furnace under development by C. A. Olsen Mfg. Co., Elyria, Ohio. Generator is rated at 130 watts, converting heat of burning gas directly into electricity. Advantages of such a unit are its independence of electric supply and the gradual start-up and shut-down of blower as unit is activated and de-activated. Generator consists of four modules 8¼ inches high by 4¼ inches wide by 2½ inches deep, one of which is shown being installed.

Following is the text of his address to the Conference, which was held in conjunction with the 12th Plant Maintenance & Engineering Show in Chicago this past January.

"White rooms" have been defined generally to mean areas where there is a definitely controlled atmosphere as it pertains to humidity, cleanliness, temperature, and pressure. The purpose of this paper will be to present two distinct approaches to "white rooms" as we have experienced them in the past three years. The first approach to be discussed will concern attempts to establish a mass area of 65,000 square feet as a snow-white area controlling humidity, temperature, cleanliness, and pressure through rather conventional means. The second approach will concern the establishment of a small laboratory utilizing less conventional but highly effective means of control.

The objective of the first or "massive" area control was to provide a working space for several thousand persons manufacturing semi-conductor devices without the encumbrance of numerous dry boxes and specifically controlled individual work stations. This attempt has not been as successful as desired; yet, it has not been discouragingly unsuccessful. Many things have been learned about air flow and humidity control which can be applied readily and economically under certain conditions to be presented later.

(Continued on page 10)

And for Pepsi-Cola — A FUTURE OF FAULTLESS SERVICE

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NEW YORK PLUMBERS SPECIALTIES CO., INC.
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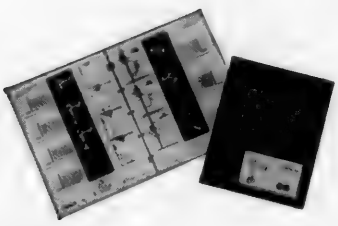
AMERICAN RADIATOR & STANDARD SANITARY CORP.
plumbing fixtures manufacturer

A small but brilliant gem of architecture is the eleven story Pepsi-Cola World Headquarters Building, recently completed as nerve center for Pepsi-Cola bottling operations around the globe. Erected at a cost of nearly $8,000,000, this gleaming glass and aluminum Delany installation has won high critical acclaim from many sources.

Continuing the growing tradition of welcome-open space in a heavily concentrated section of Manhattan, a planted plaza has been created for the passing public by setting back the building on two sides. Here, as many Pepsi-Cola bottling facilities, Delany diaphragm type Flush Valves were selected in keeping with the high standards that a fine building deserves. For years to come, these Delany Valves will readily meet performance requirements through characteristics made possible by advanced design and construction. In evaluating flush valves, investigate Delany . . . for a future of faultless service.



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WHITE ROOMS

(Continued from page 8)

The objective of the second approach was to provide minute control of at least two variables such as temperature and cleanliness during the conduct of various experiments. The design and development of this laboratory has proven to be successful and well worth the time, effort, and money spent in its construction.

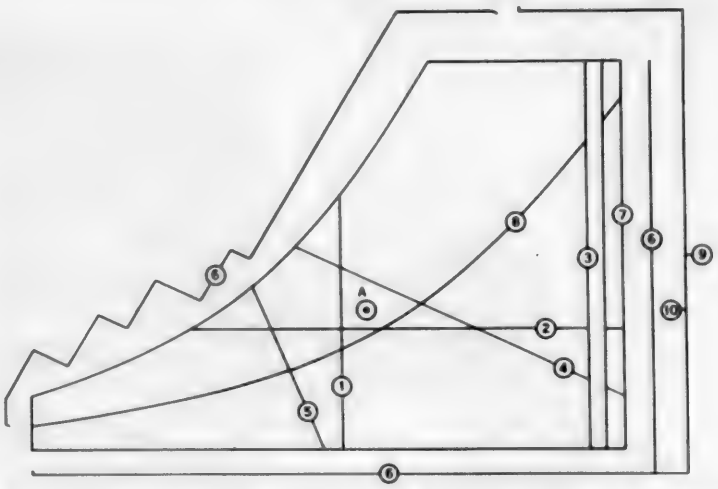
As noted earlier, the area to be controlled totaled about 65,000 square feet with a total cubage of approximately 800,000 cubic feet. Temperature at working level was to be 78 deg F, relative humidity 20%, dust free, with a slight positive pressure within the room. The consulting mechanical engineers who designed the system spent several months visiting, reviewing, and considering plants where similar criteria had been established. Two systems for removing moisture from large quantities of air were considered. One system involved the use of a corrosive salt solution, and the other a glycol solution. Neither system included desicant-type driers, due to obvious air quantity problems.

Glycol System Most Economical

After considerable cost analysis, it was decided that the glycol system offered the best answer from an initial and daily maintenance cost standpoint. Briefly, this system works thusly: Glycol has an affinity for water when it is cool or cold and has a tendency to give up its moisture when it is hot. Therefore, in a piece of equipment called a conditioner, the chemical is cooled to about 50 deg by coils supplied with 40 deg water from conventional air-conditioner compressors.

The cooled chemical is sprayed downward in a rather fine mist while the air to be treated is passed upward through the mist. The air then passes through a series of baffles to drop out all carry-over chemical. As the

(Continued on page 12)



Skeleton psychrometric chart. 1. Dry bulb temperature line; 2. Humidity ratio line; 3. Humidity ratio scale; 4. Wet bulb temperature line; 5. Specific volume line; 6. Enthalpy scales; 7. Dewpoint temperature scale; 8. relative humidity line; 9. Vapor pressure scale; 10. Sensible heat ratio scale; and *A*, Index point for sensible heat ratio scale.

New Psychrometric Chart Used With Straightedge Only

A new psychometric chart, designed for greater utility and accuracy in the selection of air conditioning systems and equipment, has been developed by The Trane Company, La Crosse, Wis. The chart is self-contained and provides information needed to solve almost all air conditioning problems without reference to auxiliary material. It also reduces error to less than one per cent, Trane says.

The chart is said to have these advantages: (1) It is based on the latest psychrometric data published by the American Society of Heating, Refrigerating and Air Conditioning Engineers. (2) Plotting may be done with any straightedge. Auxiliary rulers, triangles, and protractors, required with other charts, have been eliminated. (3) Exact enthalpy values (total heat) are read directly and require no correction, eliminating auxiliary reference tables. Avoided is the error resulting when lines of constant enthalpy and wet bulb are assumed to be equal.

(4) Greater accuracy in calculation, plotting and printing has reduced error to less than one per cent. (As much as 5% error is possible on other charts now in common use, Trane says.) (5) Rectangular coordinates permit the slope of a line to be easily transferred from one point to another. (6) Constant specific volume lines for each 0.2 cu ft per lb increase the charts fan calculation value.

(7) Constant relative humidity lines are included instead of percentage humidity which has become relatively obsolete in modern air conditioning engineering calculation. (8) The use of horizontal humidity ratio lines, and the addition of a vapor pressure scale, increases the chart's value in moisture calculations.

(9) Three-color printing makes the chart easier to read. (10) It can be reproduced on most commonly used office copy machines, and is standard size, with a margin for simple inclusion in reports, when folded in half.

The new chart obsoletes a Trane chart that has been widely used since its introduction in 1934. Further information is available from local Trane sales offices or by writing The Trane Company, La Crosse, Wis.

McQUAY heavy duty, air cooled Aircon condensers are constructed to give complete, dependable operation for either refrigeration or air conditioning —or both. They are available in horizontal or vertical air flow models in 19 sizes from 7½ to 100 tons nominal capacity in a single unit. Unlimited capacity is available in multiple unit installations. The low profile, quiet operation, flexibility and the economy in installation and operation make the McQuay Aircon ideal for every installation. The McQuay Seasontrol, available as an accessory, offers automatic head pressure control for use any time of the year, winter or summer. For complete information call your local McQuay representative, or write McQuay, Inc., 1619 Broadway Street N. E., Minneapolis 13, Minnesota.

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19 SIZES • 7½ TO 100 TONS IN A SINGLE UNIT

McQuay INC.

AIR CONDITIONING • HEATING • REFRIGERATION

For more data circle this page number on card at back of book

WHITE ROOMS

(Continued from page 10)

chemical in the reservoir at the bottom of the conditioner becomes diluted, it is pumped to another piece of equipment called a concentrator. Here the reverse operation occurs, with steam from a low-pressure boiler furnishing the heat. Atmospheric air is filtered in and passed through a fine spray of hot chemical, normally about 175 deg, and the moisture is carried off into the air. When the diluted glycol and concentrated glycol are pumped between the reservoirs, they pass through a small heat exchanger to pre-heat the diluted chemical and cool the concentrated chemical. Pneumatic controls are used to determine when liquid should be pumped from one reservoir to the other. This equipment formed the basis for humidity control.

Due to the accessibility of the area involved from below the floor level, and variance in cooling-load requirements from spot to spot, several small air-handling units were selected to provide temperature control. There were eventually some 48 4,000-cfm units located to service this area. Each unit had dual piping and coils with proper bypasses controlled by proportioning valves. Thermostats were located in the return air stream. Each unit contained a set of commercial-grade filters and a mixing box where fresh, dry air at 53 deg was mixed with return air from the work area.

To this point, I have described briefly the temperature and humidity control equipment, but not the air-borne contamination-elimination equipment. All fresh air to this area entered the system at one point. Prior to drying, it was prefiltered through fiberglass media, filtered through an electro-static precipitator of the dry cell type, and then through the rolling-type fiberglass media to clean it down to the 5-10 micron range.

(Continued on page 120)

EARNINGS OF ENGINEERS CONTINUE UPWARD TREND

Engineers' salary levels rose approximately 5% per year between 1958 and 1960 according to a survey conducted by the Engineering Manpower Commission of Engineers Joint Council. The overall median annual salary now stands at $9,600. The recent increase of 5% may be compared with an average annual increase of 6½% between the years 1953-1958. Seven years ago (1953), the first in this series of surveys found the median salary for engineers at $6500. These findings were made public recently by EMC in the fourth of a series of surveys entitled, "Professional Income of Engineers—1960" which covers approximately 200,000 engineering graduates in industry, education and government.

The report which was announced by Dr. Sydney B. Ingram, newly elected Chairman of the Engineering Manpower Commission, also shows that engineers are a young group, with median age of about 32, based on a graduation average age of 22. Salaries increase more during the early years of an engineer's career and begin to slow down at about 20 years of experience. Recently, this tendency has been less pronounced.

There is a marked difference between engineering salaries in industry, government and education, with the highest level in industry, followed by education and government. Of particular note is the 14.3% increase in the total professional income of engineering teachers between 1958 and 1960.

The Engineers Joint Council's report contains data on engineers' salaries in 22 subdivisions of industry.

Earnings of engineers continued their upward trend, observed in the previous survey intervals 1953-56-58. The overall median (for all graduates) was $6,500 in 1953, $7,750 in 1956, $8,750 in 1958 (about 6.5% annually) and $9,600 in 1960 (up about 5% annually). The latter represents an increase from mid-1958 to mid-1960. For this same two-year span the Consumer Price Index rose 2.3% and the average Gross Weekly Earnings for Production (Manufacturing) climbed close to 8.9%.

Summary income data; median income is tabulated below.

Copies of the report are available from the Engineering Manpower Commission, 29 West 39 Street, New York 18, New York, at three dollars a copy—slightly lower in bulk.

ANNUAL EARNINGS (MEDIANS)

Years of Experience	All	Industry	Education	Government
1	6725	6775	5375	6275
5	8100	8200	7350	7175
15	11000	11250	10950	9075
10	9875	9975	9100	8750
28	12450	12575	12575	10650

OIL BURNER SMOKE EMISSION STUDIED AT MICHIGAN STATE

A research project concerned with smoke emission factors of oil heating equipment is under way at Michigan State University under the direction of Charles Pesterfield, professor of mechanical engineering and technical secretary, Commercial-Industrial Section, Manufacturers' Div., Oil-Heat Institute of America, Inc. (OHI). It will devote itself to a complete study of smoke emission and the chemical composition of such smoke arising from the operation of oil burners.

Lack of data has seriously handicapped the industry, OHI said.

Problem: Exhaust hoods that don't exhaust

This plant needs make-up air! If the exhaust hoods in your plant aren't doing their full job, chances are they are being outpulled by other fans. Other exhaust fans set up a vacuum by removing air faster than you replace it. Your plant needs make-up air...a supply of new air to replace exhausted air.

Without sufficient make-up air, exhaust hoods can't do their job properly. Plant air becomes contaminated with fumes, dust, and odors. Workers' health suffers. Absenteeism rises; production lags. Other vacuum problems crop up: hot spots at inside areas, cold drafts along walls.

Solution: install a make-up air system -- fans to bring in outside air, and heaters to temper it. A make-up air system like this cancels out vacuum, gives balanced heat and ventilation.

For technical help on make-up air, see your Consulting Engineer. Or call in Sturtevant application engineers. They're experts in handling air...whether you want to move it, heat, cool or clean it. J-60711

WESTINGHOUSE ELECTRIC CORPORATION
Sturtevant Division, Dept. CVII.
Hyde Park 36, Mass.

Send me your make-up air booklet.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

PHONE_____

You can be sure...if it's **Westinghouse**

For more data circle this page number on card at back of book

Ready soon-see your

NEW! Simple field test for hermetic burnouts

plus

NEW! Easy way to clean out mildly contaminated systems

* Full information on these important new developments—plus test kits and pressurized cylinders of "Genetron" 11—will be available from your wholesaler about March 15. See him then!

Genetron Wholesaler*!

General Chemical takes the guesswork out of hermetic burnouts

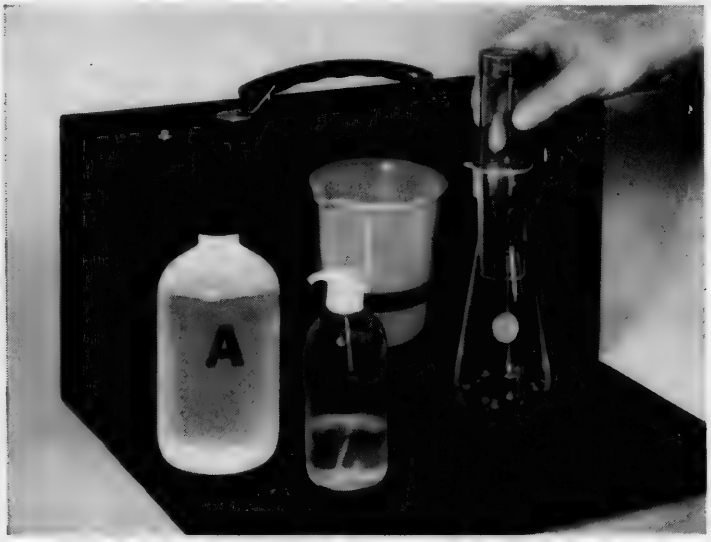
One of the oldest and toughest service problems in the refrigeration and air-conditioning industry has been licked!

Until now, there was no quick, on-the-spot test to determine the degree of acidity in a system after hermetic burnout . . . and there was no easy way to tell when the acid in a system had been cleaned out.

To solve this problem, General Chemical has developed the first simple field test for checking degree of contamination in a burned-out system—before and after cleanout. Yes—we've taken the guesswork out of hermetic burnouts.

In addition, General Chemical has developed an easy, short-cut procedure for cleaning out mildly contaminated systems by using pressurized cylinders of "Genetron" 11 to flush the unit—quickly and without pumping.

See how these new developments can save you time, labor and material costs:



First practical field test method! With this handy, portable kit developed by General Chemical, you can now quickly and easily determine extent of contamination in a system after hermetic burnout. Simple tests show extent of burnout contamination and what clean-up procedure should be used. Also show when cleaning is complete.

New quick, easy way to clean minor burnouts! Mildly contaminated systems can now be flushed and cleaned without pumping by using special new pressurized cylinders of "Genetron" 11 solvent. Prepared especially for flushing burnouts, these pressurized cylinders will soon be available from your wholesaler. An excellent solvent, "Genetron" 11 flushes acids and moisture, loosens and removes solids and is safe to handle.

Here is still another contribution by General Chemical to the advancement of the air conditioning and refrigeration industry. These new procedures will be demonstrated at meetings conducted by "Genetron" wholesalers, RSES chapters and other organizations, in the months to come.

genetron®
super-dry refrigerants

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N.Y.

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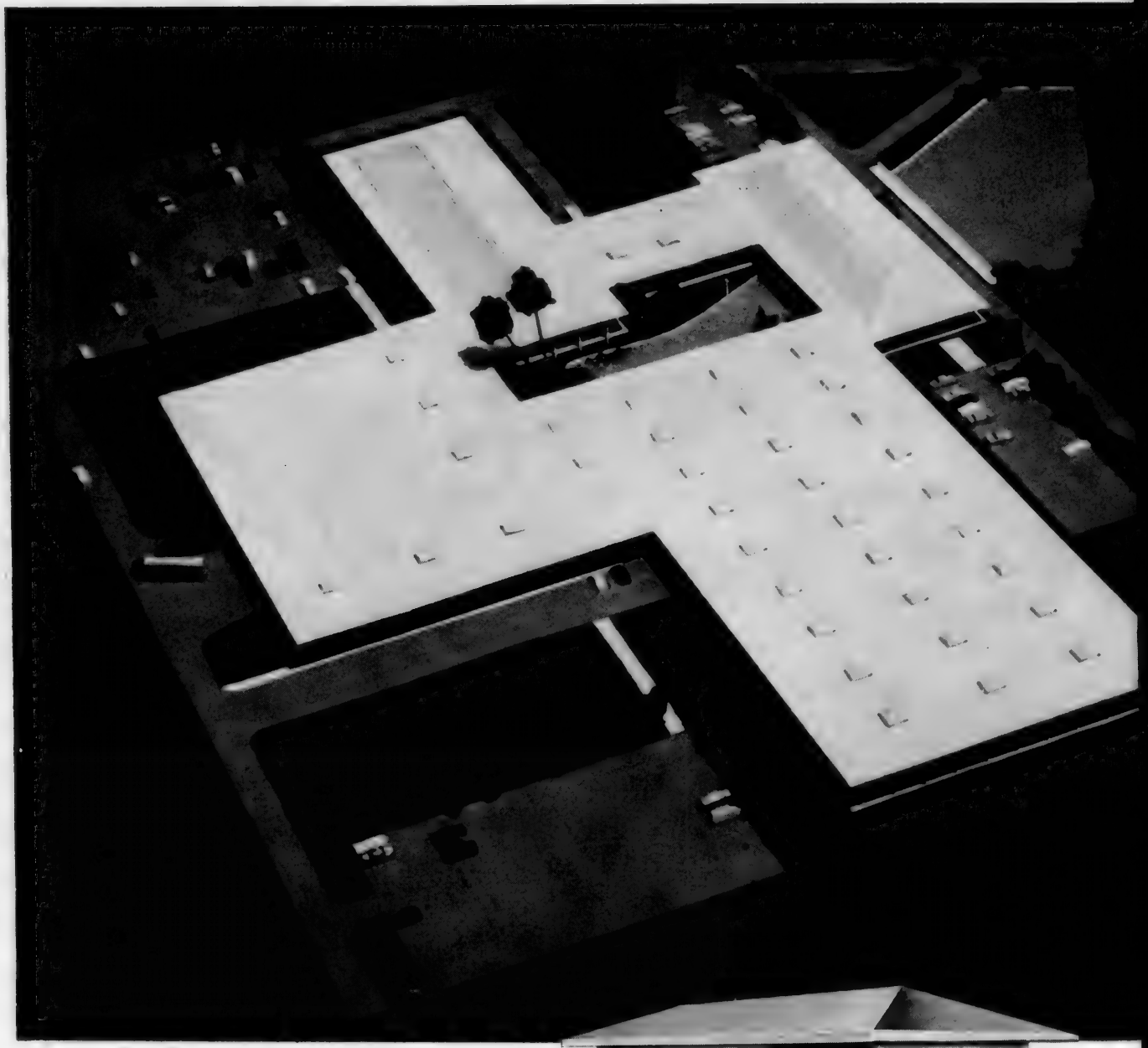


Architect: Malcolm B. Wells, Merchantville, N. J.
Consulting Engineer: Arthur Parker Assoc., Moorestown, N. J.

NOTE HOW CLEVERLY THE ARCHITECT has made the unobtrusive Atmos-Pak units even less noticeable by adding a hip roof to each unit to match the buildings' architectural features. Painted beige, they conform to the color scheme of the group.

The roof-mounted technique, primarily for cooling and/or heating new one-story buildings, can be used in existing structures of various types. It can be modified to perform the functions of any conventional system.

There's always room at the top for the original low silhouette.

Write for Complete Information

Atmos-Pak... Roof-Mounted Heating and Cooling... Pioneered... Designed... Manufactured by

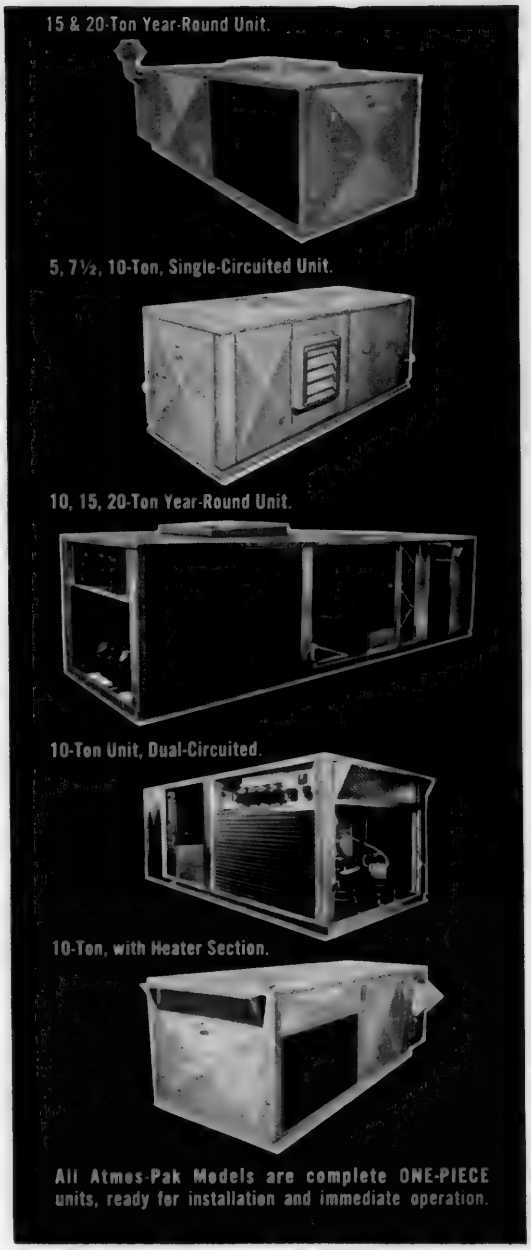
AIR CONDITIONING INC.

88 North Highland Avenue, Ossining, New York

the atmos-pak

Patent No. 2886955

ROOF-MOUNTED ATMOS-PAK® GIVES RCA PLANT HEATING & COOLING EFFICIENCY, SPACE, BEAUTY!


15 & 20-Ton Year-Round Unit.
5, 7½, 10-Ton, Single-Circuited Unit.
10, 15, 20-Ton Year-Round Unit.
10-Ton Unit, Dual-Circuited.
10-Ton, with Heater Section.
All Atmos-Pak Models are complete ONE-PIECE units, ready for installation and immediate operation.

New Model Computer Plant in Palm Beach Gardens, Fla., Installs Versatile Units

Everything that went into the model new $4,000,000 RCA Electronic Computer Plant was carefully chosen, painstakingly scrutinized by architect and engineer. It had to be best in its field. So with pride, Air Conditioning Inc. announces the inclusion of 58 Atmos-Pak units comprising 1000 tons capacity to satisfy all requirements and to meet the RCA architects' and engineers' standards for an efficient and attractive building group.

Speed of installation was essential. Pre-fabricated Atmos-Pak, needing only three connections on-site, speeds occupancy. Valuable space is gained at no extra cost by eliminating boiler and apparatus rooms. Air cooling makes water towers, evaporative condensers, miles of pipe, and other appurtenances unnecessary. Ducts are eliminated by the supply and return air distribution chamber. Zone control of cooling and heating is easy. Expansion means merely adding more Atmos-Pak units.

These and other advantages can be yours. Architect, engineer, builder, owner, occupant, contractor, financer, all benefit when Atmos-Pak is specified for cooling and/or heating. For information, advice, or counsel on heating and cooling one-story buildings please write.

For trouble-free underground hot pipe insulation specify GILSULATE® with Engineer-Supervised Installation

Every engineer charged with the responsibility of designing a central heating system to heat all buildings of a college, institution or industrial plant knows the money-saving advantages of such a system if properly planned. But he is aware that planning the underground piping can involve many problems, for the system must provide proper insulation and also protect pipes against corrosion, chemical and electrical attack.

The easy, one-step solution to many of the problems of underground hot pipe insulation is to call the GILSULATE distributor in your area: first, for the superior quality of the insulation material he sells and, secondly, for the excellent service he has to offer.

GILSULATE is a naturally-occurring mineral which, because of its unique chemical and physical properties, is chemically neutral in all soils, dielectric, impervious to mold, rodents and plant growth, and is water-resistant. Its thermal efficiency, low installation cost and long service life are supported by extensive laboratory and field research, and also by years of successful use in thousands of installations throughout the world.

Service that saves time and trouble—It is as important to our reputation that GILSULATE be used properly as it is for the engineer to assure his customer of an efficient, economical installation. Our distributors' experienced mechanical engineers will work with you in preparing underground piping plans, checking soil conditions and arranging for supervision of the installation work. And, without any cost to you, plans and specifications will be checked by American Gilsonite's Engineering Department.

Full-time engineer supervision of installations—Every GILSULATE installation of 30 tons or more is supervised by an American Gilsonite Company field service representative who stays on the job until it is completed. Smaller jobs are inspected by the distributor's engineer. This is a guarantee to everyone concerned...owner, architect, engineer, mechanical contractor and materials supplier...that every step of the job will be exactly to specifications.

Without obligation, we will be pleased to send you technical information on GILSULATE insulation so you can evaluate the merits of this low-cost, poured-in-place material. We will also put your name on the mailing list to receive free copies of PIPE INSULATION NEWS.

Once you have learned the merits of GILSULATE, we feel certain you will want to write your "specs" to assure the use of GILSULATE...*with engineer-supervised installation.*

FACTS ABOUT GILSULATE

1. **Easy-to-use**—just pour, shovelpoint and tamp...pipe heat does the rest.
2. **Forms protection against heat loss** and all hazards commonly encountered by buried hot pipes.
3. **Needs no housing or mechanical sheaths:** no mixing, special handling or equipment.
4. **Only needs normal pipe spacing:** for multiple pipe or cramped conditions.
5. **Four types available:**
   Type A for 220-300° F. temp. range
   Type B for 300-365° F. temp. range
   Type Special B for 365-420° F. temp. range
   Type C for 420-520° F. temp. range

THE INSULATION FOR LIFETIME PROTECTION OF UNDERGROUND HOT PIPES

GILSULATE®

AMERICAN GILSONITE COMPANY

Municipal Airport P. O. Box 15, Salt Lake City, Utah
Affiliate of Barber Oil Corp. & Standard Oil Co. of California
Distributors in Principal Countries of the World

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from "Chicago"

For Hot Water Systems, Cold Water Systems, Air Conditioning, General Industrial use

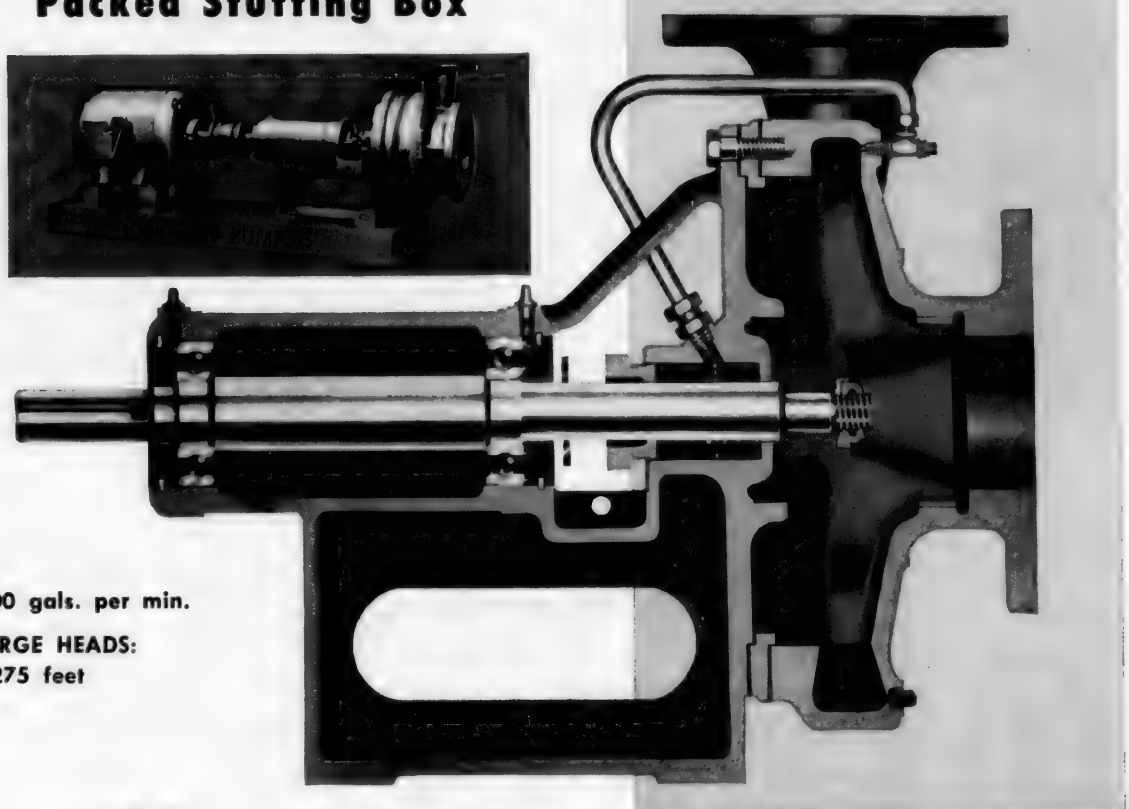
The NEW FCP

FLEXIBLE-COUPLED PACKED

CENTRIFUGAL PUMP with Packed Stuffing Box

CHECK THESE 5 "Chicago" FEATURES

1. Designed for hot water heating systems with temperatures to 250° F.
2. Successfully handles impurities normally present in heated and unheated water systems.
3. Quiet operation.
4. Constructed to give efficient, trouble free operation.
5. Backed by more than 50 years experience building quality pumps.



- 5 to 900 gals. per min.
- DISCHARGE HEADS: 10 to 275 feet

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
HYDRODYNAMICS DIVISION

CHICAGO PUMP

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Write for Bulletins 107 and 107-H

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LENNOX

A Single Source for Heating, Ventilating, Air Conditioning in Business, Industry and Schools

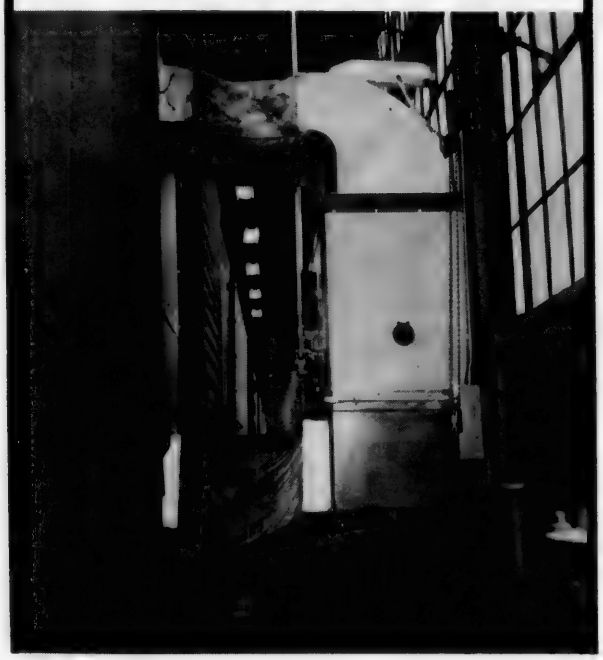
PROBLEM: TO PROVIDE YEAR 'ROUND COMFORT FOR 12 DIFFERENT ZONES IN A 40,000 SQ. FT. LIBRARY

Lennox solution: Ten Lennox LANDMARK® units provide individually controlled heating and cooling for each zone. The main floor, with six rooms, is supplied a total of 23,300 CFM and 60½-tons cooling. Four mezzanine rooms are served by three 10-ton LANDMARK® units. The basement area utilizes the same equipment used on the 1st floor and mezzanine. Air-cooled condenser-compressor units are located on concrete pads outside the central equipment room.

Now, Lennox offers you a complete line of warm air heating and air conditioning equipment . . . all from *one central source.* Huge-capacity industrial heaters with up to 2,000,000 Btuh capacities . . . unit and duct heaters . . . COMFORT CURTAIN® systems for schools . . . air conditioning equipment for every size job . . . all designed, tested and manufactured in our own factories. You deal with one company, represented by one man. He's a professional heating and air conditioning technician, ready to become a part of your team. He'll relieve you of bothersome details and red tape, and make sure you have the right equipment on the job, when you need it. For more complete information on the Lennox line of heating and air conditioning equipment, write LENNOX, 613 S. 12th Ave., Marshalltown, Iowa, or phone your nearest Lennox office listed on the facing page and ask a technical representative to call.

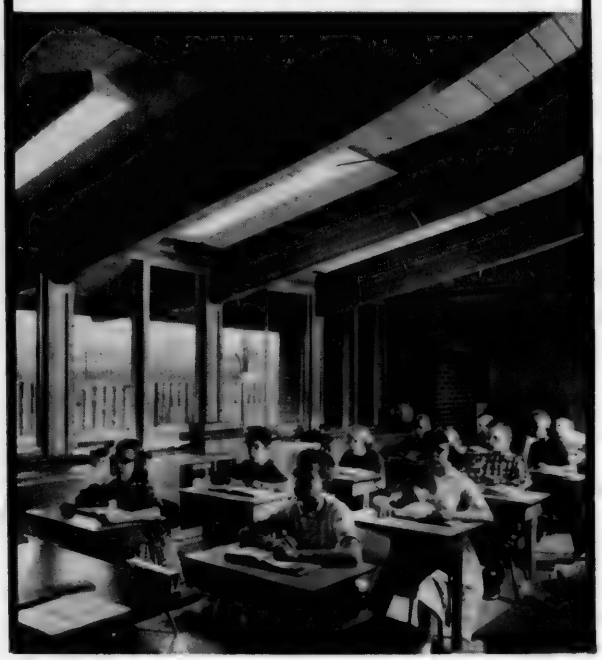
PROBLEM: RAISE THE TEMPERATURE OF CRUDE RUBBER STORED IN BOXCARS, FROM OUTSIDE TEMPERATURES TO 120° F.

Lennox solution: 500,000 Btuh unit heaters are connected by canvas ducts to incoming boxcars loaded with crude rubber. When the load is heated, the canvas ducts are easily disconnected and another boxcar is brought into position. The Lennox units are designed to provide the high discharge air temperatures required for this type of process without affecting their efficiency and long life. Lennox direct-fired heaters, ranging in capacities up to 2,000,000 Btuh, are used extensively in industry for heating, cooling, ventilating, make-up air and process application.



PROBLEM: HEAT, FRESH-AIR COOL AND VENTILATE A 12-CLASSROOM SCHOOL FOR LESS THAN $1.25 PER SQ. FT.

Lennox solution: A Lennox COMFORT CURTAIN® system that provides individual room-controlled fresh-air, cooling, ventilating and heating installed for only $1.07 per sq. ft. Gas fired heating sources, in approved construction heater rooms, are located on exterior walls between each two classrooms. An air processing unit in each room meters precise amounts of fresh, heated or return air through functional bookshelf duct sections across the full length of each classroom exterior wall. Minimum structural requirements and ease of installation reduced both initial cost and over-all expenditures.



Don't be satisfied with less than

LENNOX

HEATS • COOLS • TREATS AND MOVES AIR

IN HOMES IN CHURCHES IN SCHOOLS IN BUSINESS IN INDUSTRY

LENNOX INDUSTRIES INC., FOUNDED 1895 — MARSHALLTOWN AND DES MOINES, IOWA; COLUMBUS, OHIO; SYRACUSE, NEW YORK; DECATUR, GEORGIA; FT. WORTH, TEXAS; SALT LAKE CITY, UTAH; LOS ANGELES, CALIFORNIA. LENNOX INDUSTRIES (CANADA) LTD. — TORONTO, MONTREAL, CALGARY, VANCOUVER, WINNIPEG.

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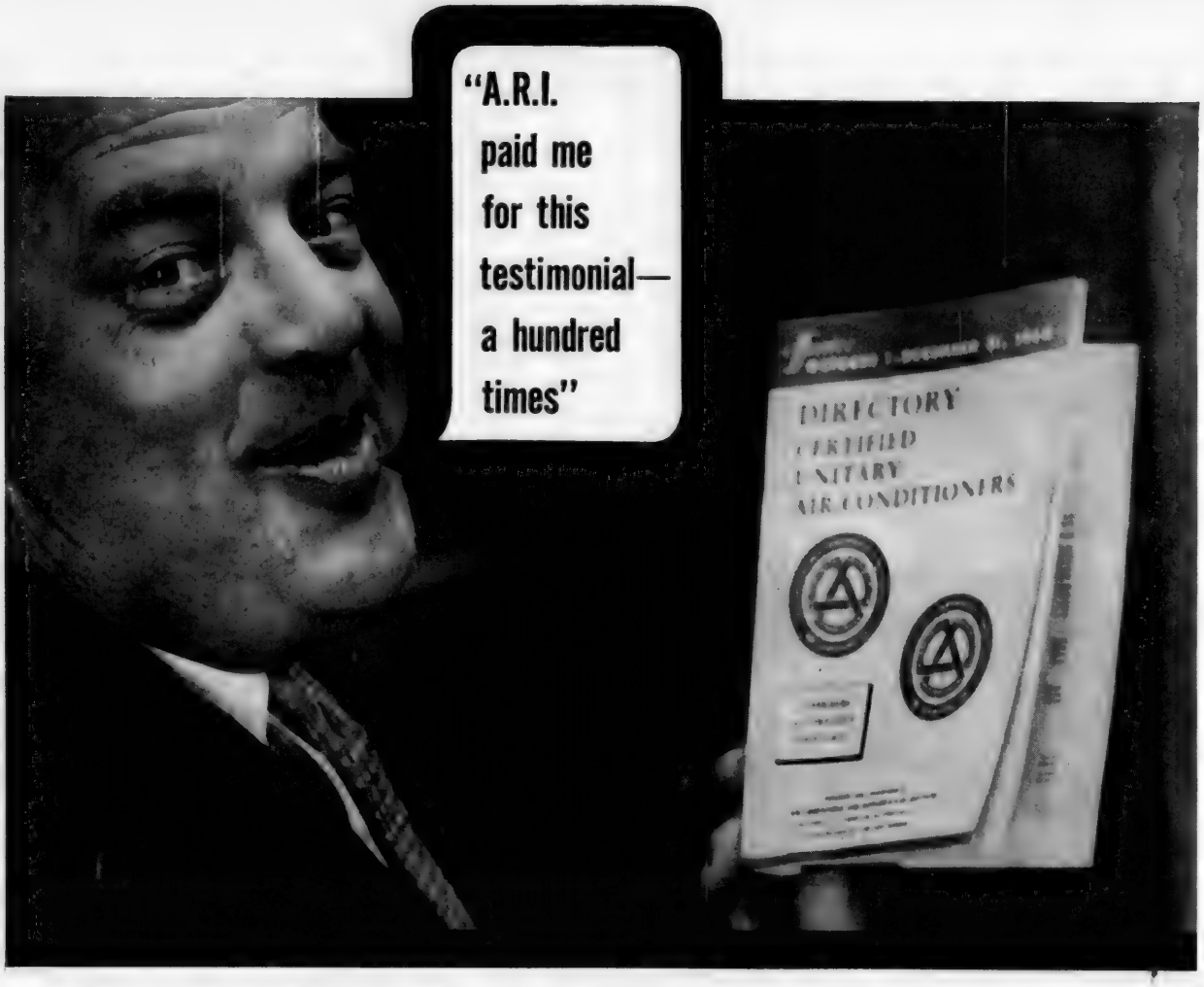

Mr. Louis E. Bake, *Air-Conditioning Dealer,* says:*

"Selling with the A.R.I. Directory is easier, faster, more profitable."

How profitable? Ask Louis Bake, who uses the ARI Directory regularly, finds it a big help in closing sales, and a major factor in his company's 50% sales increase in 1960.

"When I show customers that the unitary system I'm recommending is listed in the ARI Directory, and *certified* under the program of this national association, I add authority to my presentation.

"I point out how the equipment is carefully rated under the Certification Standards, that this rating is subject to checking at any time by the Institute through an independent testing laboratory in New York. Result: I back my sales talk with the authority of the Air-Conditioning & Refrigeration Institute, give my prospects more confidence in what I say.

"I thought selling with the ARI Directory couldn't be beat—until I saw the new ARI Consumer sales piece, 'How to Buy Central Air Conditioning.' This is a *must* for any dealer who wants to tell his prospects the *how* and *why* of central air conditioning. It tells the full, technical story in words John Q. Public can understand, and helps any honest dealer sell a quality system."

Free copies of both the A.R.I. Directory and "How to Buy Central Air Conditioning" are available from:

AIR-CONDITIONING & REFRIGERATION INSTITUTE

Department B-311, 1346 Connecticut Avenue, N.W., Washington 6, D. C.

*Mr. LOUIS E. BAKE is Sales Manager of Cool-Heat Sales Company, Inc. of Washington, D. C.

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Exclusive on the Versare Liquid Chiller

New indicator system pin points trouble spots

Pilot lights greatly simplify normal maintenance. Just a glance tells if oil or evaporator pressures are too low, condenser pressure is too high, chilled-water temperature is too low, or if motor is overloaded. Other lights show whether cooling switch, crankcase heater, and liquid-line solenoid valve are on. The new Versare liquid chiller is built into a structural-steel base that protects vital parts . . . slips through 36" door openings . . . has capacities from 22 to 67 tons. Write for Bulletin 3926: American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Ltd., Toronto, Ontario.

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AMERICAN-Standard
INDUSTRIAL DIVISION
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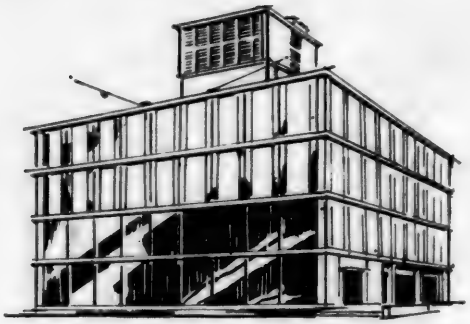
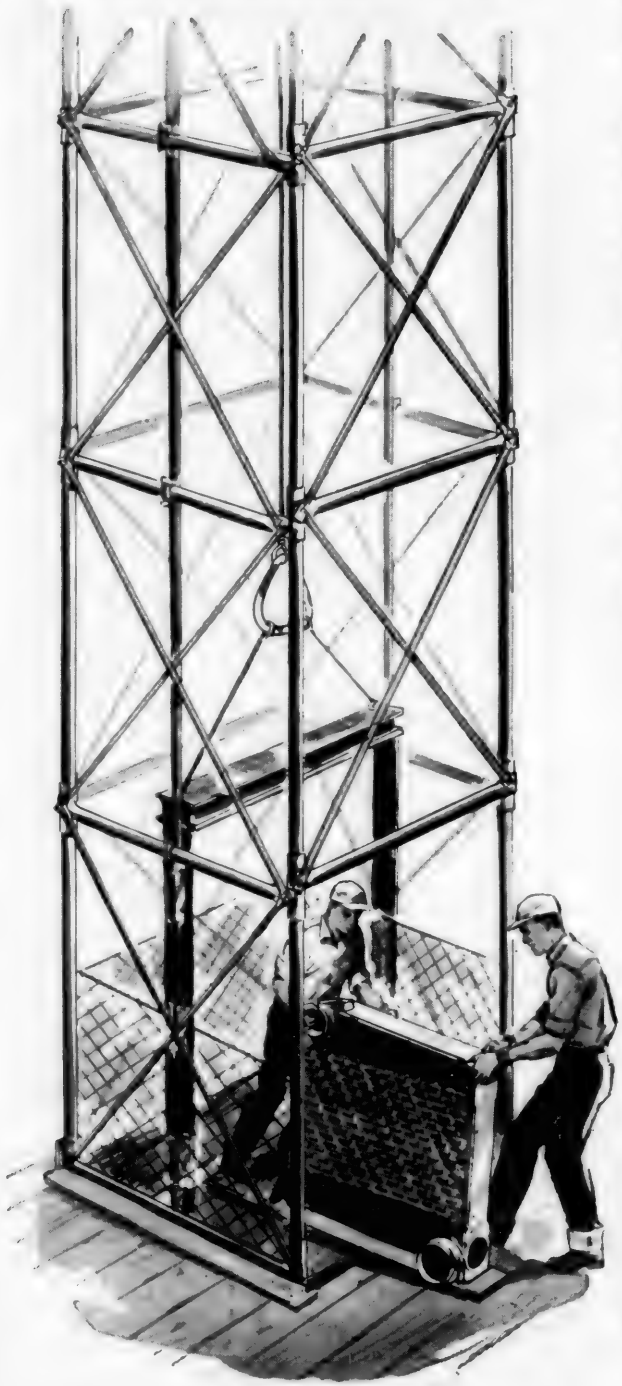


HOW TO INSTALL A BOILER IN A PENTHOUSE... *WITHOUT A DERRICK!*



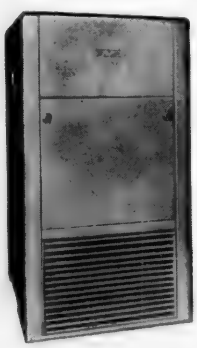
It's no trick at all with a Weil-McLain cast iron sectional boiler—either gas or oil fired. In penthouse installations, the sections can be brought up in the personnel hoist...no need to rig a derrick.

Both in new construction and in replacement work, the sectional construction of Weil-McLain Boilers is a distinct and valuable feature. The work on a new building need not be held up waiting for the arrival of the boiler...nor must the boiler be installed before the building is completed, subjecting it to weather, construction damage or vandalism.

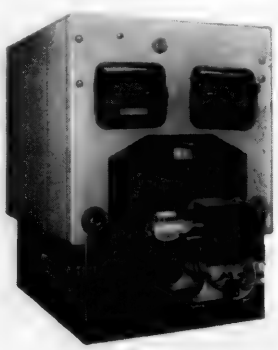
If a boiler is to be completely replaced, a Weil-McLain cast iron boiler can be moved in through an ordinary door, section by section. If additional capacity is required, a second boiler can be installed to supplement the original boiler. Or, additional sections can be added to the present boiler. Weil-McLain Boilers are assembled with short draw rods, a feature which simplifies erection and assures freedom from stresses and strains.

For detailed information on Weil-McLain Oil Boilers, see Engineers' Product File or Sweet's Architectural File. For current Gas Boiler data, send for Bulletin C-297.

WEIL-McLAIN BOILERS FOR COMMERCIAL AND INDUSTRIAL HEATING SYSTEMS



FOR GAS
Capacities to
3,354,000 BTU/hr.



FOR OIL
Capacities to
2,942,500 BTU/hr.

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CAST IRON BOILERS

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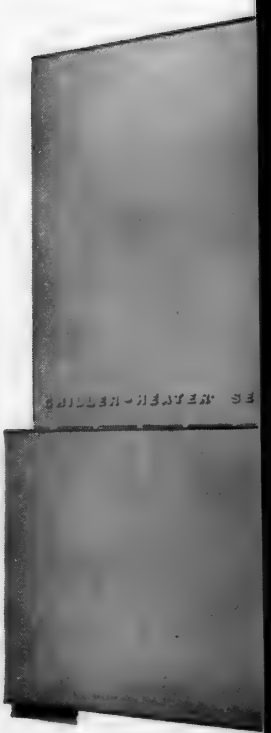
THE GAS INDUSTRY ANNOUNCES . . .



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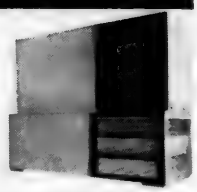
A MAJOR BREAKTHROUGH IN COOLING & HEATING

ARKLA'S NEW 25-TON GAS CHILLER-HEATER



Here it is – the revolutionary new Arkla absorption unit that heats and cools without a steam producing boiler or converter. Gas-fired burners in the generator section energize the system for absorption cooling, or for heating. It's the perfect system for modern year 'round gas air conditioning.

INSTANTLY HEATS AND COOLS AUTOMATICALLY ◀ HEATS WATER WITHOUT A BOILER ◀ COOLS WATER WITHOUT A COMPRESSOR ◀ REQUIRES NO LUBRICATION ◀ SEALED FOR LIFE, REQUIRING MINIMUM MAINTENANCE ◀ MAINTAINS SAME CAPACITY FOR THE LIFE OF THE UNIT ◀ HAS NO MOVING PARTS IN THE HEATING AND COOLING CYCLE ◀ FIRST MEDIUM OR LARGE TONNAGE AIR CONDITIONER THAT HEATS.

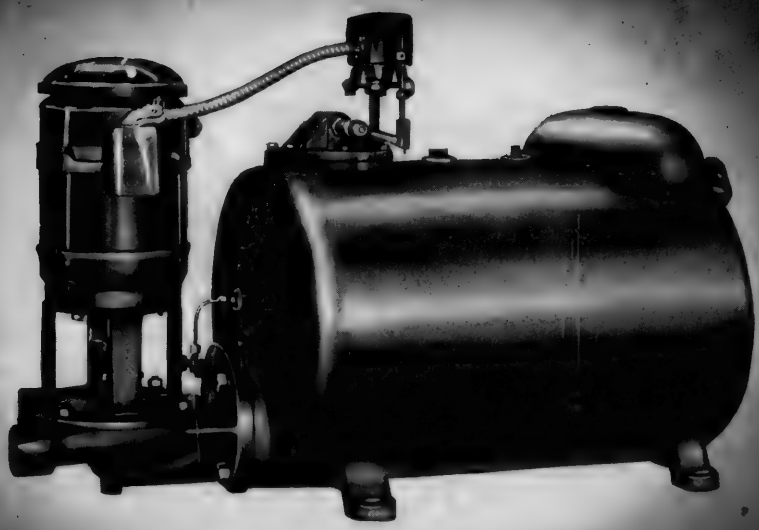
Truly revolutionary... investigate for your next building project the new Arkla DF-3000 Gas-Fired All Year* Chiller-Heater.

For details contact your local Gas Company. Or write Arkla Air Conditioning Corporation, 812 Main Street, Little Rock, Arkansas.

American Gas Association

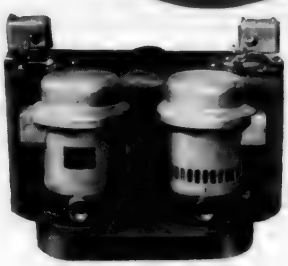
FOR HEATING & COOLING GAS IS GOOD BUSINESS!

One is just right for your application



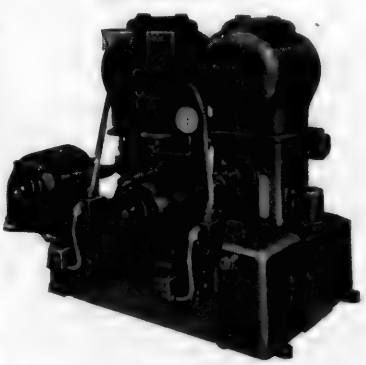
SKIDMORE "VC" CONDENSATION PUMP

- Quiet Operation • Low inlet connection
- Accessibility Without Disturbing Piping

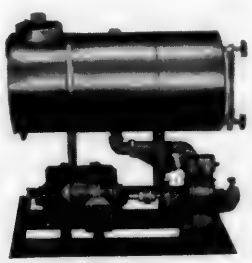


TYPE CCVS—DUPLEX
Bulletin No. 21-C

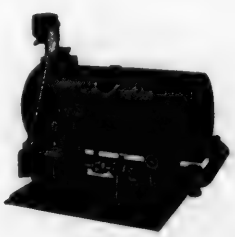
You can meet your exacting needs in heating pumps with Skidmore. For quiet, dependable operation, a Skidmore Pump combines the latest features in centrifugal pump design with a minimum of space requirements and a wide range of selectivity. Designed to return condensate to the boiler or other points . . . pump unit operates **free** of any close-clearances, assuring longer operational periods without cost for service or maintenance.



VACUUM PUMP
Bulletin No. 9-B



TYPE TM
Bulletin No. 17

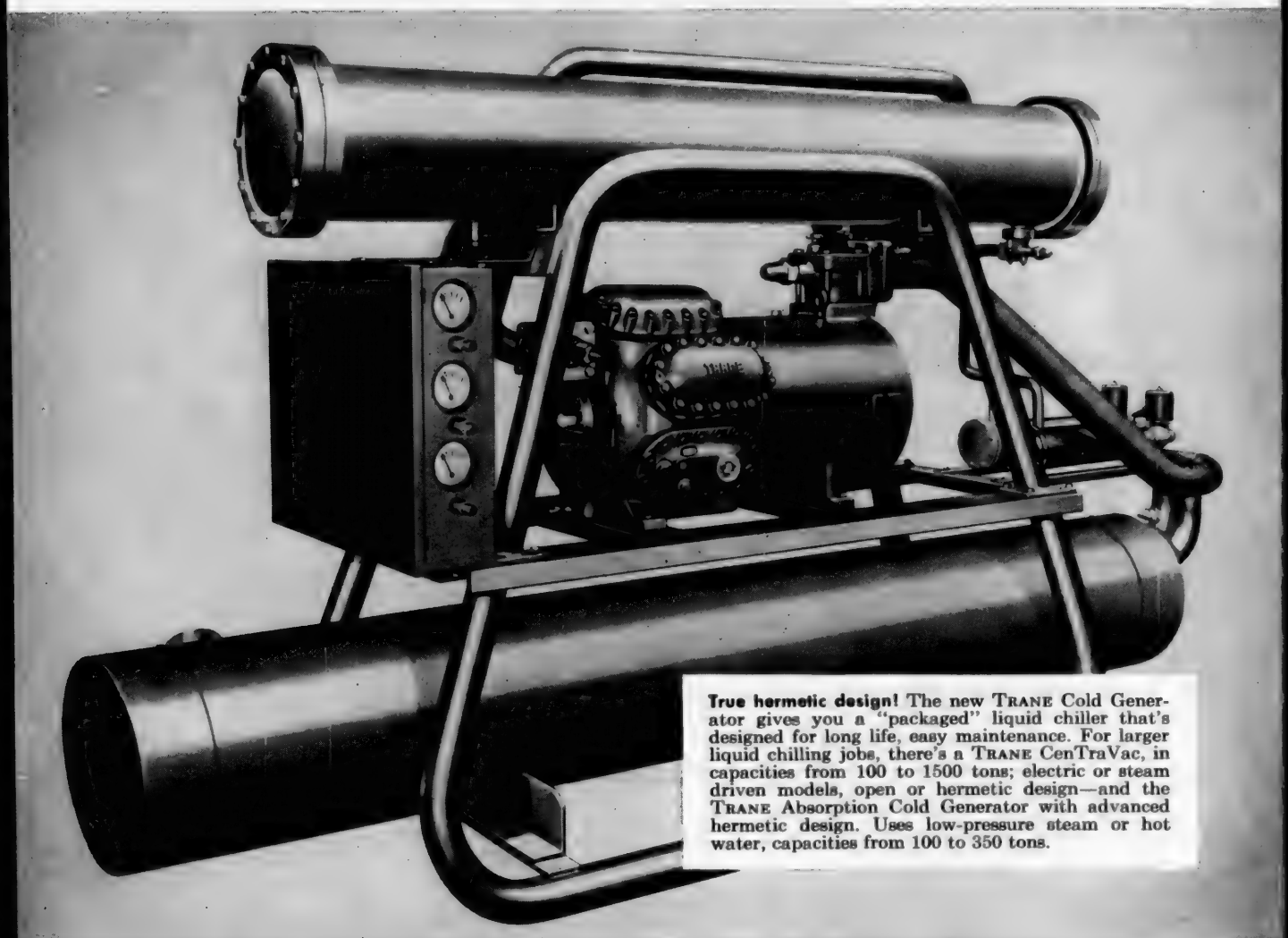


TYPE HS
Bulletin No. 14-B

SKIDMORE CORPORATION, ST. JOSEPH, MICHIGAN

For more data circle this page number on card at back of book

Cut liquid chilling costs- with this new Trane



True hermetic design! The new TRANE Cold Generator gives you a "packaged" liquid chiller that's designed for long life, easy maintenance. For larger liquid chilling jobs, there's a TRANE CenTraVac, in capacities from 100 to 1500 tons; electric or steam driven models, open or hermetic design—and the TRANE Absorption Cold Generator with advanced hermetic design. Uses low-pressure steam or hot water, capacities from 100 to 350 tons.

Now! A hermetic model of the Trane Reciprocating Compressor!

Here's a new, efficient Reciprocating Compressor that's *fully hermetic*, designed for the more rigorous demands of R-22. This unit is of single-housing construction. Motor and compressor are in one shell, with a bolted end cover for easy access. This minimizes alignment problems experienced with other hermetic compressors that have 2-part housing.

The new TRANE Hermetic Reciprocating Compressor has multi-step capacity control that saves power by reducing starting, stopping. And the truly hermetic design eliminates crankshaft seal and coupling to provide quiet operation, simplified installation, longer life.

Check these features:

- **Designed for R-22 and R-12** (not a converted R-12 machine).
- **Single-housing construction** for simplified installation, trouble-free operation, easy access for maintenance.
- **Multi-step capacity control** reduces starting, stopping, saves power.
- **Exclusive internal thermal protector,** located in the motor windings, protects against any condition that causes high motor temperatures.
- **Large suction chamber** and cylinder head safety springs provide protection against refrigerant slugging.
- **Available** in sizes from 10 to 150 tons.

for comfort or process-
Hermetic Cold Generator

Advanced hermetic design assures long, trouble-free life, quiet operation. Cuts installation costs.

Here's low-cost, efficient liquid cooling for process or comfort—from TRANE, long an industry leader in reciprocating water chillers. It's the new TRANE Reciprocating Cold Generator, now *hermetic*, with TRANE chiller and condenser —plus a new TRANE Hermetic Compressor (illustrated and described below).

A major step forward in industrial liquid cooling equipment, this new Hermetic Cold Generator features lightweight, compact design that simplifies installation and maintenance. It is completely factory-wired and assembled, with prewired control panel mounted directly on the unit to eliminate much on-the-job installation labor. Designed for R-22 and R-12, it is available in a complete range of 11 sizes from 10 to 100 tons.

When you plan industrial liquid chilling equipment—for processing or air conditioning—contact your nearby TRANE Sales Office for facts on the complete line of TRANE water chillers from 10 to 1500 tons; or write TRANE, La Crosse, Wisconsin.

Check these advanced TRANE features:

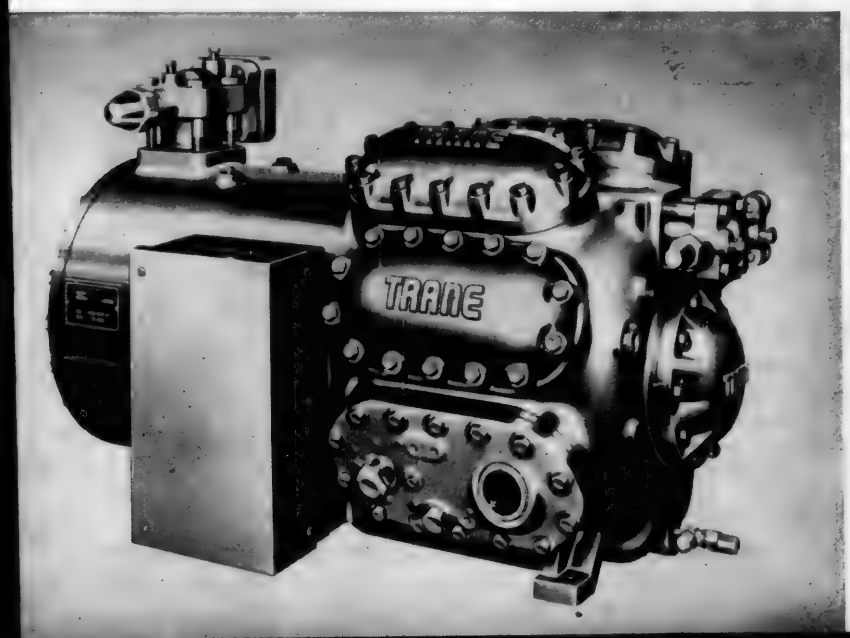
- **All major components,** chiller, condenser, compressor, designed and built by TRANE.
- **Advanced hermetic design** assures maximum efficiency, simplified maintenance and installation.
- **Compact size;** small enough to pass through a standard 36″-wide door.
- **Packaged design;** factory-wired and assembled to cut on-the-job labor. Pneumatic or electric control panel mounted and prewired.
- **Versatile.** May be used for any process or comfort liquid cooling application . . . to maintain constant temperature for electro-plating baths and other critical operations. Units available for use with evaporative or air-cooled condensers.

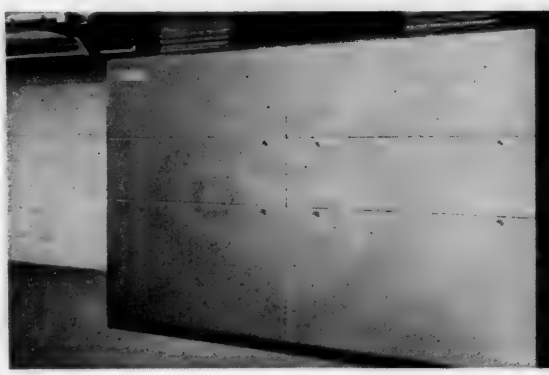
For any air condition, turn to

TRANE

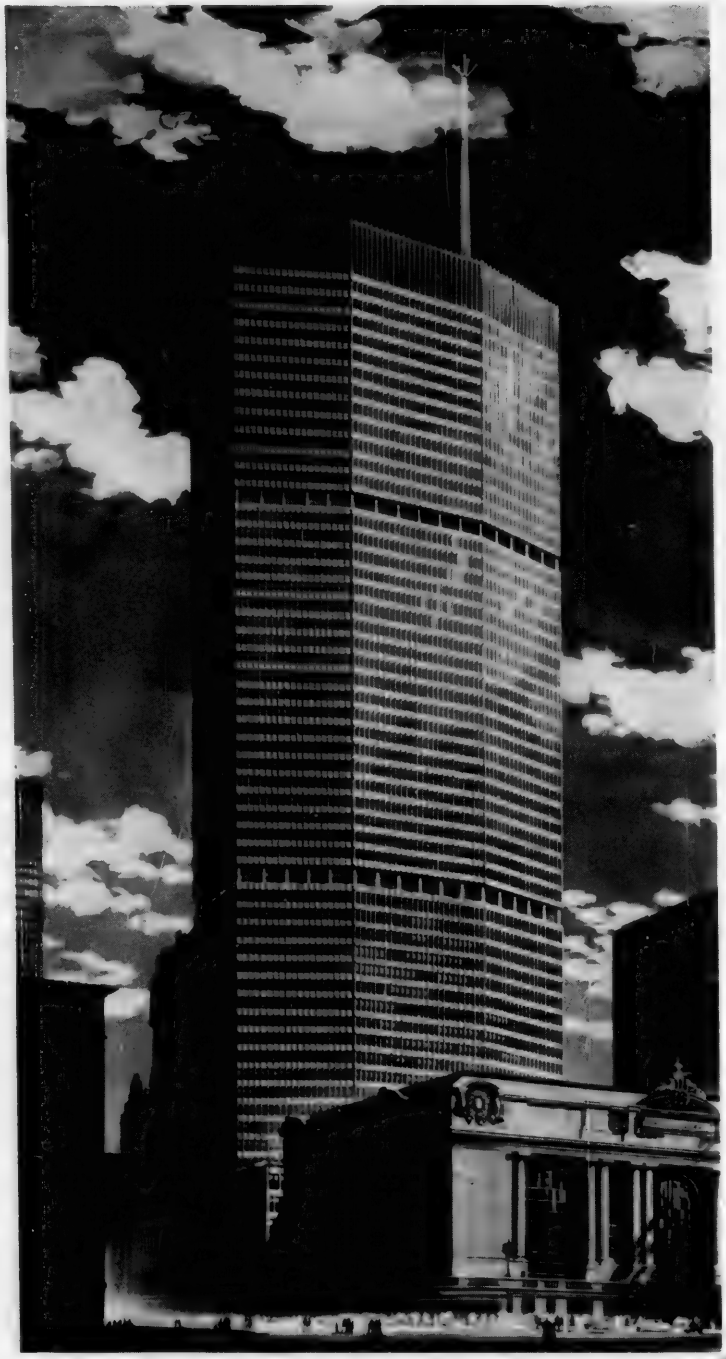
MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U. S. AND 19 CANADIAN OFFICES





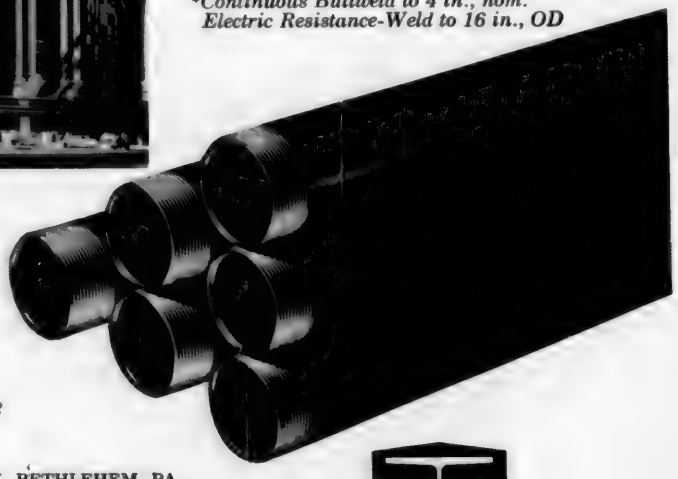
Trane Commercial Self-Contained Air Conditioners feature the new TRANE Hermetic Compressor. Quiet and compact, these units provide maximum cooling comfort for office, laboratory or factory areas. Job-matched to fit your budget, fit your needs. Air or water-cooled models in sizes from 10 to 50 tons.



"City in the sky" will be heated and air conditioned with the help of some 2000 tons of Bethlehem Steel Pipe*

Pan Am Building, the world's largest commercial office building, is scheduled for completion in late 1962. Rising 59 stories tall, on a site directly behind New York's Grand Central Station, it will house a population of 25,000 people working in nearly 22,000,000 cubic feet of air-conditioned comfort.

Continuous Buttweld to 4 in., nom. Electric Resistance-Weld to 16 in., OD



Owner: Grand Central Building, Inc.; Erwin S. Wolfson, President; Jack Cotton, Chairman. Architects: Emery Roth and Sons. Design Consultants: Walter Gropius; Pietro Belluschi. Structural Engineer: James Ruderman. Mechanical and Electrical Engineers: Jaros, Baum and Bolles. General Contractor: Diesel Construction Company, Inc.; Carl A. Morse, President. Mechanical Contractor: Raisler Corp. Pipe Jobber: Chas. F. Guyon, Inc.

Always insist on steel pipe made in U.S.A.

Steel

for Strength ... Economy ... Versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

THE BIG CONDENSING UNITS WITH THE FANDAIRE DESIGN

AIR-COOLED CONDENSERS

Now Fandaire Condensing Units are available in a full range of sizes from 3 HP through 90 HP – complete with the Fandaire air-cooled condenser and single, dual or multiple compressors.

Units use the original circular design that incorporates exclusive Yuba fintube with its high heat-dissipating efficiency. Every degree of temperature drop is fully used as the circular design approaches true counterflow—where the coolest air is in contact with the coolest gas. Its powerful fan pulls air in from the sides where it is as much as 4° cooler than air from below. Warm used air is pushed up and away. As air is captured from *any* direction, *any* breeze increases the unit's capacity.

The Fandaire Condensing Unit has the highest ratio of capacity to actual size of any condensing unit on the market today.

Installation is easy—no field assembly required. Factory assembly is included in the price. Get full details today on the *big* condensing units with the Fandaire design. Special quotes on custom units.

3-30 HP (single compressor)
10-60 HP (dual compressor)
60-90 HP (multiple compressors)

YUBA

specialists in circular air-cooled condensers and condensing units

YUBA FANDAIRE DIVISION
Tulsa, Oklahoma

YUBA CONSOLIDATED INDUSTRIES, INC.

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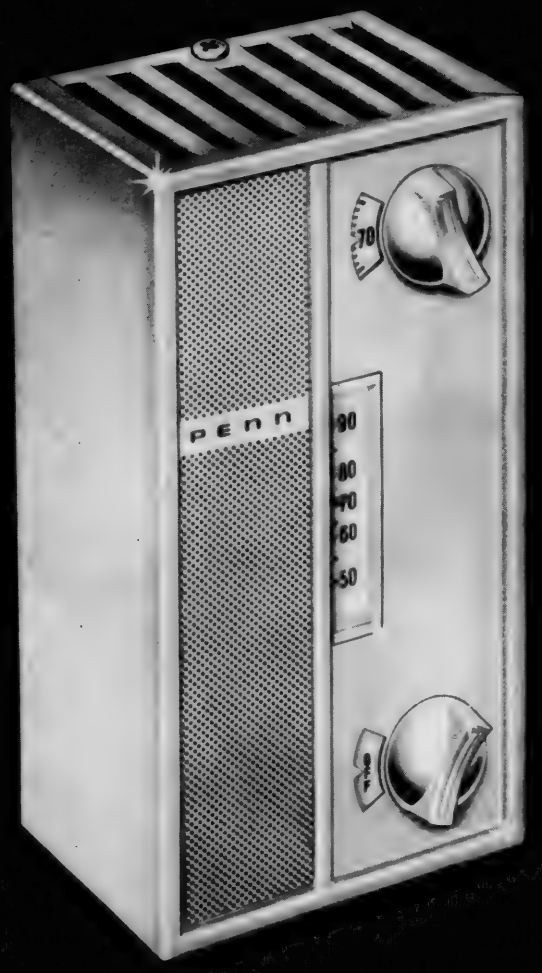
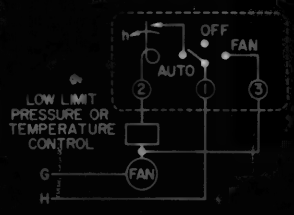
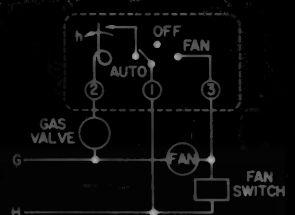


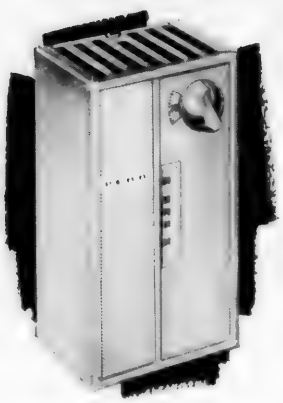
NEW UNIT HEATER THERMOSTAT



Typical application of Type 822A7 with AUTO-OFF-FAN selector on steam or hot water coil unit.



Typical application of Type 822A7 with AUTO-OFF-FAN selector on gas-fired unit heater.



Series 822, with or without function selector knob, rated for ¼ hp. service. Series 824, without function selector, is rated for 1 hp. service.

features easy-to-use, locking-type knobs for heating and summer ventilation

Here's the modern line-voltage thermostat with beautiful "slim-line" styling. Its built-in AUTO-OFF-FAN selector assures year 'round efficiency of unit heaters . . . saves fuel in winter . . . provides ventilation in summer.

It has easy-to-read temperature and function selector dials. It has exclusive, locking-type adjusting knobs, attached to cover but connected to adjusting shafts by factory-installed "keys" within the knobs. It has a built-in, concealed adjustable high limit stop for temperature dial. It has low operating differential at all voltages and amperages within its rating. It has easiest field wiring ever . . . simply connect to large terminals *on back of thermostat*. And, it has many more features you'll want. Learn more about this better thermostat for unit heaters . . . write to the Penn factory.

PENN CONTROLS, INC. Goshen, Indiana

EXPORT DIVISION: 27 E. 38th ST., NEW YORK, N.Y.

AUTOMATIC CONTROLS FOR HEATING, REFRIGERATION, AIR CONDITIONING, APPLIANCES, PUMPS, AIR COMPRESSORS, ENGINES

For more data circle this page number on card at back of book

NEW ANACONDA COST-CUTTING KITS—to help you rough in hot and cold water lines FASTER, EASIER, BETTER

1. Nail strap to studs—no blocking, no sawing, no notching to avoid vents.

2. Fasten fittings to the perforated strap with self-tapping screws.

3. Solder the fittings to the risers—and the installation is complete.

Kits for every need

90° ELLS

1707-3-5A	Copper to F.S.P.S.	⅜"
1707-3-5A	Copper to F.S.P.S.	½"
1707-3-5A	Copper to F.S.P.S.	½" x ⅜"
1707-5A	Copper to Copper	½"

TEES

1711-5A	Copper to Copper to Copper	½"
1712-5A	Copper to Copper to F.S.P.S.	½" x ½" x ⅜"
1712-5A	Copper to Copper to F.S.P.S.	½"

THRU-WALL ADAPTER

1703-5A	Copper to F.S.P.S.	½"

Convenient—Reasonably Priced

EACH ANACONDA QUIK-RUF KIT CONTAINS: 10 Anaconda High Ear Fittings, 6 Stud Straps, 20 Self-Tapping Screws, and 12 Nails.

These new Anaconda Quik-Ruf Kits are sold by distributors of Anaconda Copper Tube and Fittings. The prices are right. So get a stock of kits now and start saving time and money right away.

0002 L

ANACONDA®

COPPER TUBE AND FITTINGS

Anaconda American Brass Company

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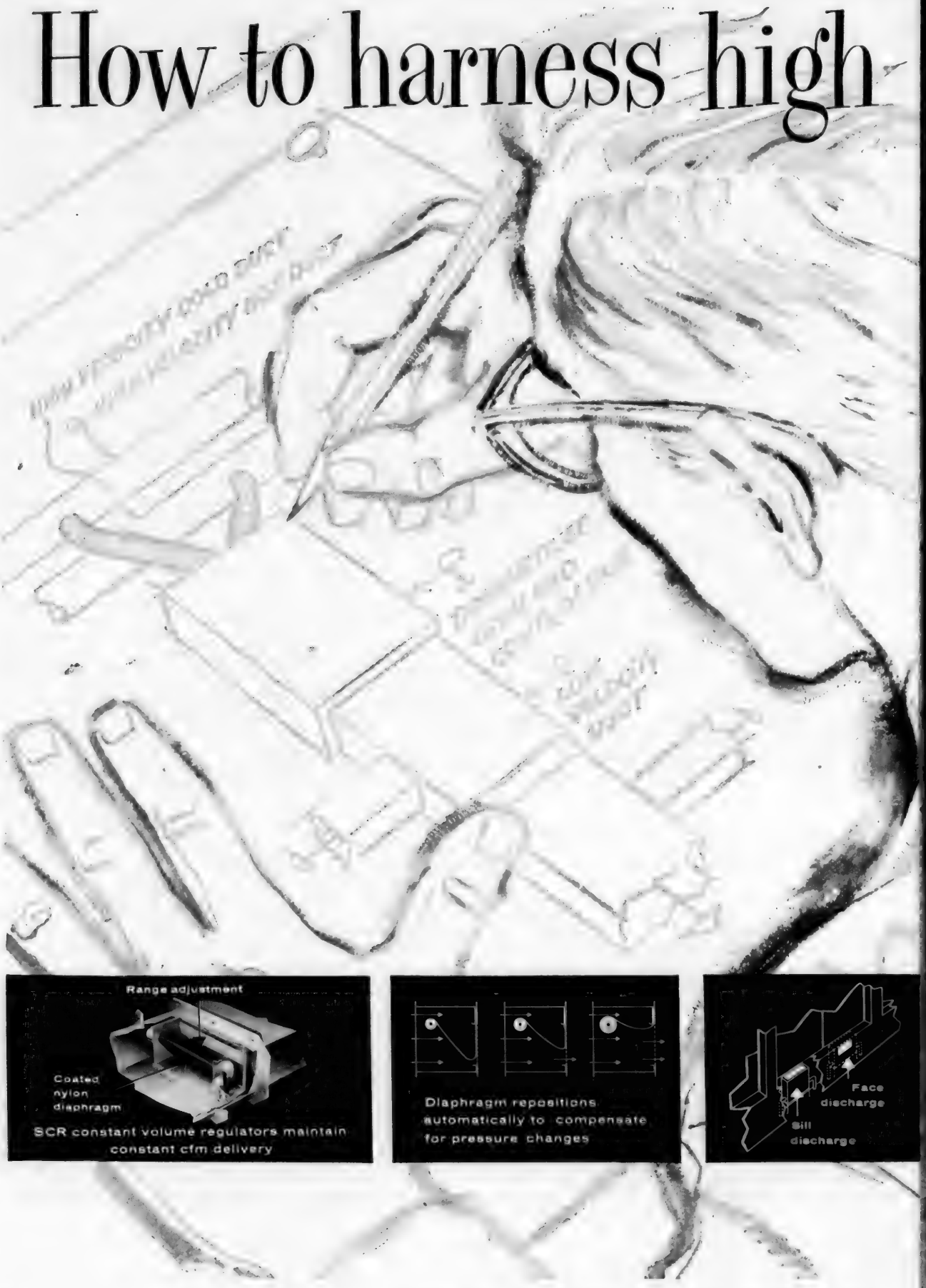
How to harness high


Range adjustment
Coated nylon diaphragm
SCR constant volume regulators maintain constant cfm delivery
Diaphragm repositions automatically to compensate for pressure changes
Face discharge
Sill discharge

velocity air

High velocity air distribution has won its spurs. Its growing use is a reflection of the important space and material costsavings which it makes possible in new construction — plus the flexibility and cost-reducing simplification which the smaller duct sizes bring about on modernization jobs.

At the same time, high velocity systems have confronted engineers with new requirements in system design and stabilization, as well as in selection and application of air distribution equipment. The problems are different than in conventional systems, but they need not be more difficult.

For over ten years Barber-Colman has conducted extensive research, testing, and development work on high velocity systems — with a resultant wealth of valuable data, plus important new high velocity air distribution products.

Barber-Colman air valves and constant volume regulators greatly simplify the design and stabilization of systems. They provide accurate, dependable means for reducing high velocities to conventional velocities, controlling hot and cold air mixing, and maintaining constant cfm delivery.

For real help on high velocity, ask for Barber-Colman's 52-page High Velocity Data File.

Single- and double-duct control units for under-window installation — sill or front discharge

BARBER COLMAN

BARBER-COLMAN COMPANY

Dept. O, 1102 Rock Street, Rockford, Illinois

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UARY–1990

TUESDAY	EVERYDAY	THURSDAY
C		1
6		8
13		15
20		22
27		29

SHOWERING COMFORT AND SAFETY FROM LAWLER SO FAR ADVANCED IT WILL NEVER GO OUT OF STYLE!

Recesso

The **Recesso's** "years ahead" styling leads the industry in thermostatic shower mixers. The **Recesso** is entirely recessed into the wall . . . eliminates dangerous protruding edges which might cause bodily injury or collect unsanitary dirt, grime and soap scum.

Lawler's advanced thermostatic element gives the **Recesso** new sensitivity and instant action for truly safe, comfortable showering. Your customers will enjoy the beauty and safety features of the **Recesso** years from now!

FOR TIMELESS PERFORMANCE STANDARDS LOOK TO LAWLER . . . FIRST!

LAWLER AUTOMATIC CONTROLS INC., MT. VERNON, N.Y.

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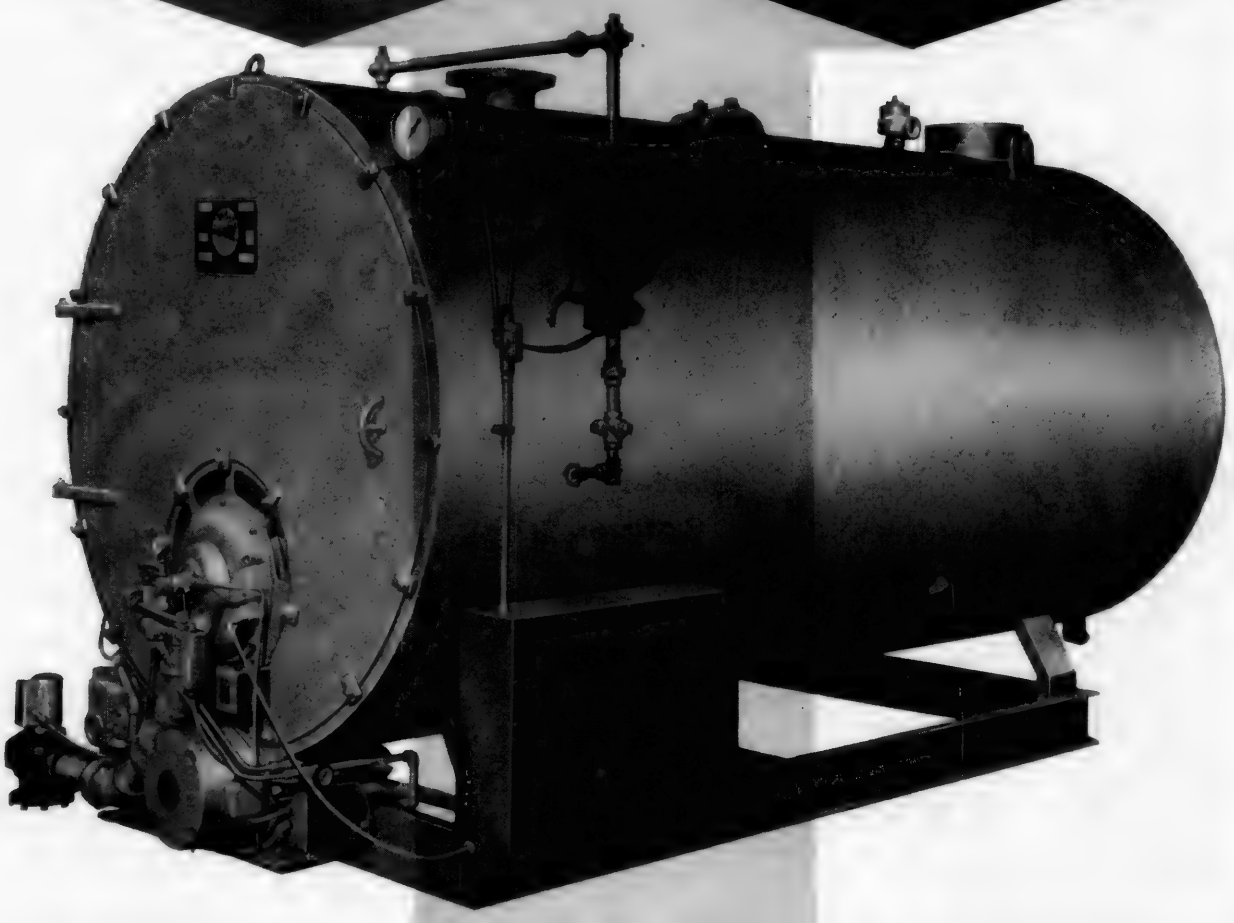
A NEW **RAY** PACKAGED BOILER

Now, For the First Time
All These Features
in a Packaged Boiler!

- Positive Viscosity Control
- Built-In Oil Heating and Circulating Pump
- Stable Oil and Gas Firing
- Beaded Tubes
- Easy Access to Firing Surfaces
- Nation-Wide Service Network



A new, space saving, fully automatic packaged boiler has been added to the Ray line! 89 years of combustion engineering experience have been put into the Ray Packaged Boiler to assure economical, trouble-free service for steam or hot water. 3-pass boiler design for maximum heat utilization, full modulation for both gas and oil, completely contained and integrated electronic control system for safety and dependability. Rated at over 80% efficiency. Gas, oil and combination gas-oil units in sizes from 40 to 300 horsepower. Call or write for complete catalog presentation.

BOILER DIVISION
RAY BURNER COMPANY
1301 San Jose Avenue, San Francisco, California

For more data circle this page number on card at back of book

FOR AIR CONDITIONING . . .

Get exact water control through

Exclusive Honeywell design makes the difference in pneumatic valves!

✓ CHECK THESE HONEYWELL DIFFERENCES:

THE ACTUATOR

1 **Rolling-type diaphragm** assures constant effective area throughout stroke, provides maximum power when needed.

2 **Snap-seal** bead on diaphragm. The higher the pressure, the tighter the seal.

3 **Bullseye stem button design** maintains smooth stem travel, eliminates side thrust, assures positive positioning.

THE VALVE

4 **Specifically designed** to modulate hot and cold water in sequence.

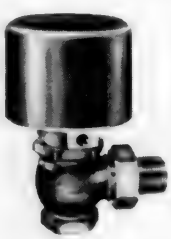
5 **Two contoured plugs** insure equal percentage output for either hot or cold flow.

6 **Body is a brass forging** and all internal parts are brass or stainless steel with rubber seals.

7 **Spring-loaded, self-adjusting** rubber packing rings eliminate field packing adjustments.

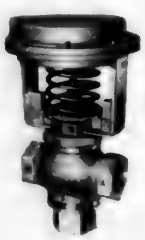
The Honeywell VP522A is the only modulating sequencing valve specifically designed to control the flow of both hot and cold water to fan-coil and induction units. This three-way, pneumatically-operated valve assures maximum power when you need it most—when the valve is approaching the closed position. The flexible, rolling-type diaphragm keeps the effective area of the actuator constant, regardless of the position of the diaphragm itself. Bullseye action by the stem retainer and contoured plug prevents side thrust, provides more sensitive, precise flow control.

The assembly is corrosion resistant. Molded-in composition discs assure tight shut-off. Two inlets and a common outlet are threaded for ½ inch, ⅜ inch and ⅞ inch OD flare fittings to cover the additional requirements of this valve. Only Honeywell offers this selection. And the actuator can be rotated 360° on the bonnet, permitting easy alignment with air piping from any direction. For full details, call your nearest Honeywell office. Or, write Honeywell, Dept. HV-3-79, Minneapolis 8, Minnesota. In Canada write Honeywell Controls, Limited, Toronto 17, Ontario.



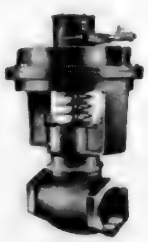
Pneumatic Radiator Valves
VP520A, VP520C

Direct-acting, normally open, single-seated valves in straight-through, straight-through offset or angle patterns. VP520A is modulating for two-pipe steam and hot water systems. VP520C is used with a 2-position controller on one-pipe steam systems.



Three-way Pneumatic Coil Valve
V5013A

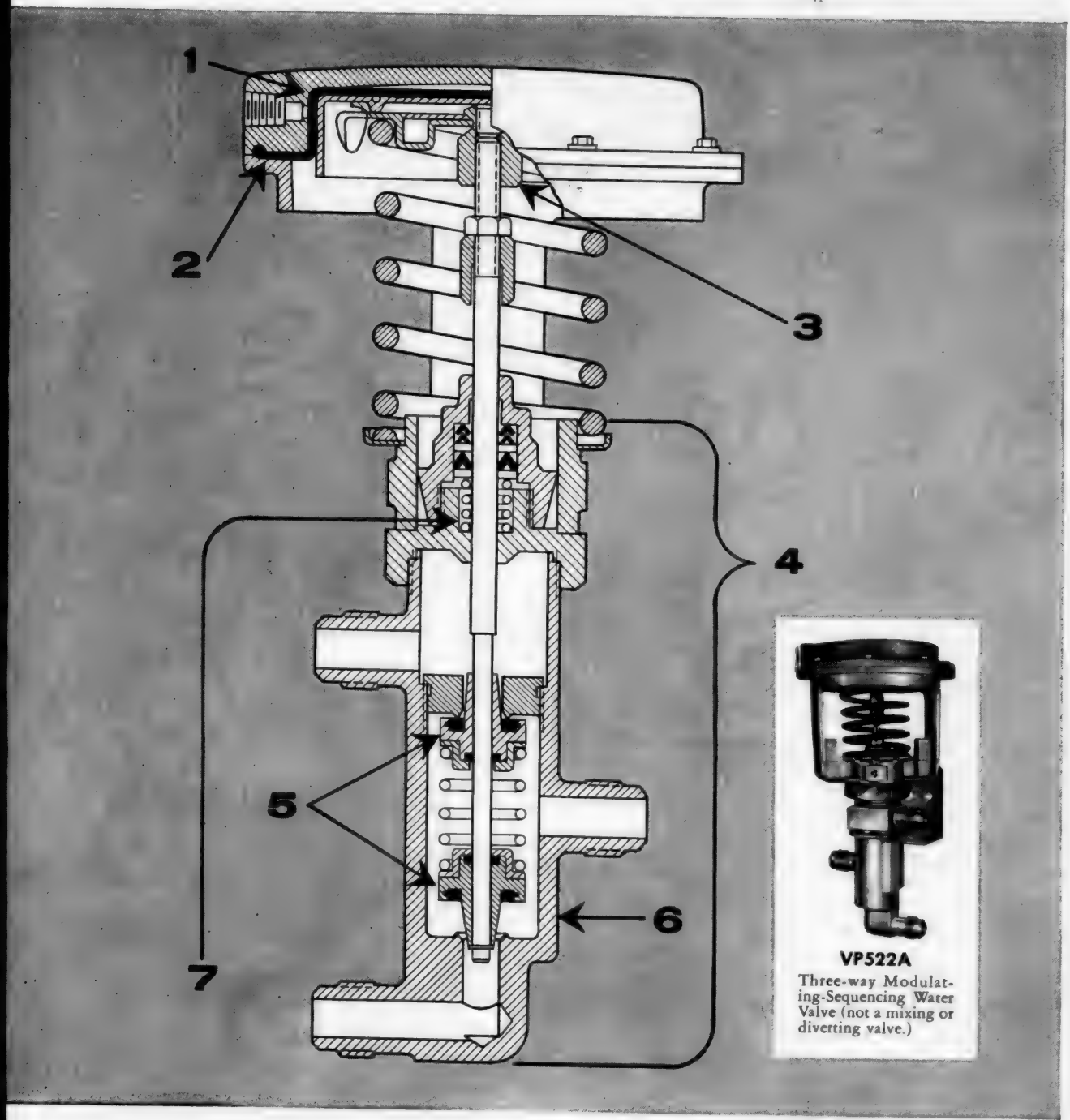
Can be used for mixing service to direct two inlets to a common outlet. Should not be used to divert flow from a common inlet to two outlets. For use with pneumatic, electric or electronic operators to form a motorized valve assembly for the control of hot or chilled water.



Single-Seated Valve Bodies
V5011A, V5011B

Straight-through, globe-type valves with cast-bronze screwed ends or cast-iron flanged ends. V5011A is direct-acting. V5011B is reverse-acting. Excellent flow control is achieved by using equal-percentage, high-lift, plug-type throttling guides.

"Constant Power" actuation



VP522A
Three-way Modulating-Sequencing Water Valve (not a mixing or diverting valve.)

Honeywell

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL
Sales and service offices in all principal cities of the world. Manufacturing in the United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

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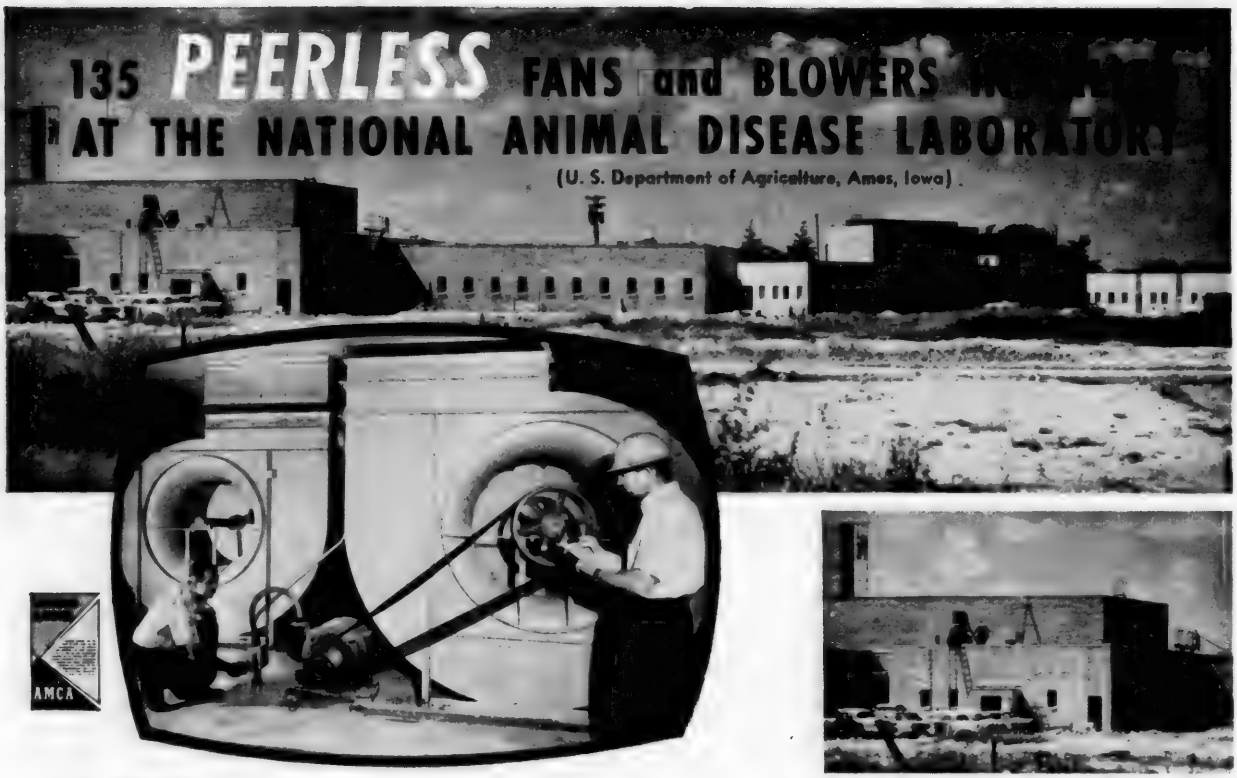
135 PEERLESS FANS and BLOWERS AT THE NATIONAL ANIMAL DISEASE LABORATORY

(U. S. Department of Agriculture, Ames, Iowa)



BUILDING NO. 2 — 30 FANS

BUILDING NO. 3 — 49 FANS

OTHER BUILDINGS — 56 FANS

ASSURE TROUBLE-FREE DEPENDABLE SERVICE

A constant supply of fresh air and an equal amount of exhaust air are of critical importance at this 14-million-dollar installation. Lack of proper ventilation would seriously undermine the success of any experiment being conducted here. For every group of supply and exhaust fans and blowers, there is stand-by equipment of identical capacity. Blowers and duct work are welded "bacteria-tight" to prevent any contamination from one research section to another. The entire installation is capable of delivering 1,042,375 cfm at capacity operation.

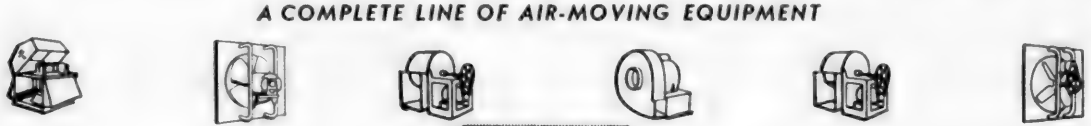
Peerless Fans and Blowers are recognized for their long, consistent and trouble-free service year after year. Write today for additional information.

ARCHITECTS AND ENGINEERS: Ralph M. Parsons Co., Los Angeles, California
Brooks-Borg, Des Moines, Iowa

GENERAL CONTRACTOR: Beck-Truckee Co., Dallas, Texas

MECHANICAL CONTRACTOR: Iowa Sheet Metal Contractors, Inc., Des Moines, Iowa

A COMPLETE LINE OF AIR-MOVING EQUIPMENT



PEERLESS ELECTRIC DIVISION
W. MARKET ST.

PORTER

H. K. PORTER COMPANY, INC.
WARREN, OHIO

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

For more data circle this page number on card at back of book

IN TUBING— Nothing Beats Copper!

IN COPPER— Nothing Beats READING!

READING Tube Corporation

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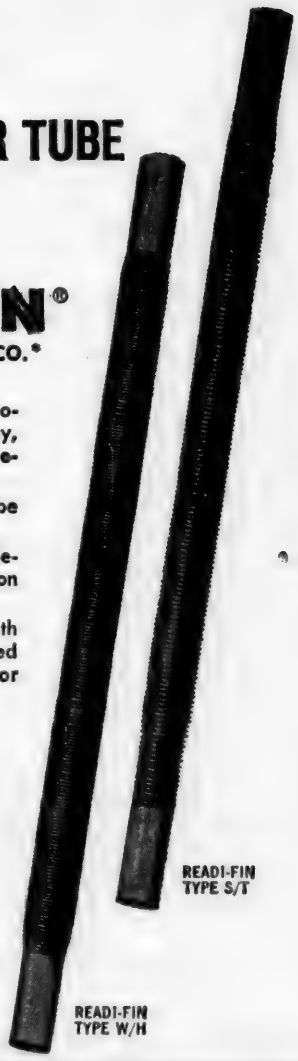

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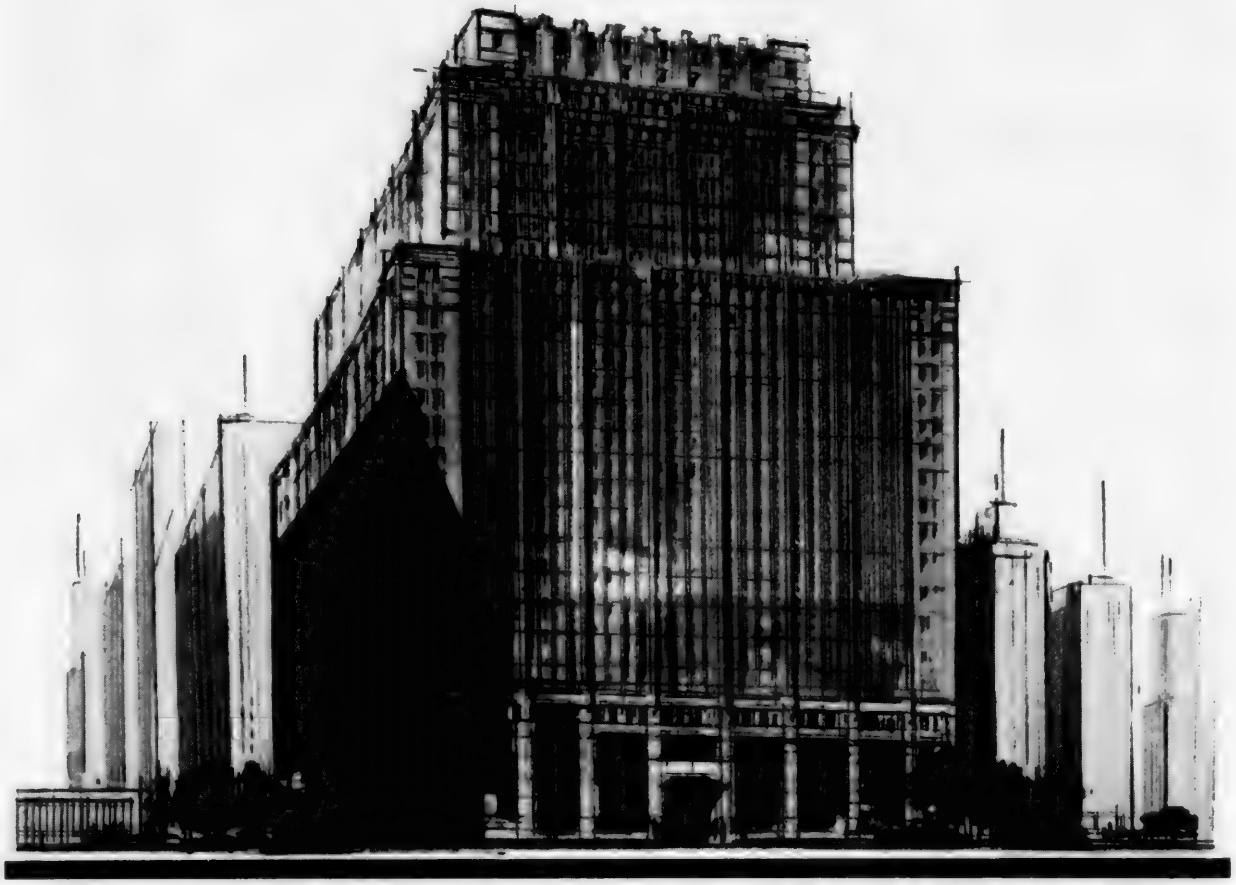

2 Park Avenue, New York City. Consulting Engineers: Sears and Kopf; Mechanical Contractor: Kennedy-Scheidel-Young, Inc.; Electrical Contractor: Theodore Kaish, Inc.

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During the past five years, scores of Chrysler air conditioners have been installed at 2 Park Avenue, New York City. What has been one of the longest air conditioning jobs in history has also been one of the most successful.

By handling this 27-story building zone by zone and floor by floor, about 1400 tons of Chrysler equipment have been installed . . . with an absolute minimum of inconvenience to tenants. As tenants move in or renew leases, they are consulted as to exact air conditioning requirements. Each then gets the system best suited to his needs.

This unusual method is flexible—Chrysler can supply packaged units, chillers or room units as needs demand. And it is economical—all air conditioning equipment taps into central electrical, water and air connections which serve the entire building.

Chrysler engineers worked closely with the consulting engineer and contractor during the advance planning of this complex air conditioning problem. They will be as happy to cooperate with you. For information on their services and Chrysler Air Conditioning equipment, write today.

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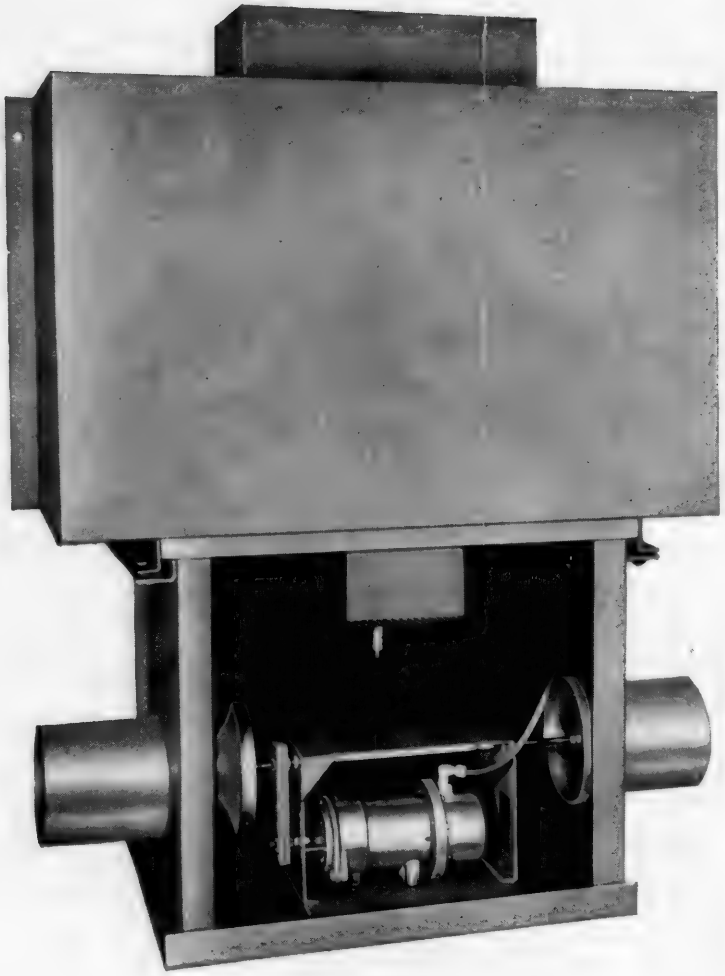

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The mixing valves proportion the hot and cold air in response to the room thermostat and the unique AGITROL volume regulator guarantees constant control of air delivery at the required volume.

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Technical catalog HV-100 contains complete performance data and dimensions on all AGITAIR units. Write for your copy today.

FEATURES

1. One motor — no linkages.
2. Aluminum inlet valves driven directly — instantaneous response . . . no lost motion . . . no backlash.
3. Unique AGITROL valve (constant volume regulator) actuated solely by the supply air.
4. Both mixing and attenuation chambers fabricated of galvanized or galvannealed steel . . . sealed to prevent air leakage.
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Lafayette Park Pavilion Apartments, Detroit, Mich.

Architect:
Mies van der Rohe

Mechanical Engineer:
William Goodman

Mechanical Contractor:
General Piping, Inc.

"THE ENTIRE HEATING, COOLING AND PLUMBING SYSTEM IS DEPENDENT UPON B&G® PUMPS"

The dual-temperature heating and cooling system of this history-making high-rise is designed around the circulation of hot or chilled water to various room air handling units. This water is circulated by two B&G U-13T Universal Pumps.

Says Albert Weiss, president of General Piping, the mechanical contractors: "The entire heating, cooling and plumbing system is dependent upon B&G Pumps —a total of 12, including two High-Velocity Boosters and two Universal Pumps.

"After the system was put into initial operation and all minor adjustments and servicing performed, we have had no service call-backs to date.

"This freedom from maintenance problems on all water circulation, as well as quietness of operation, are the main reasons why B&G Pumps were specified and why the contractor enjoys installing them."

B&G Pumps are designed and built specifically for heating and cooling systems. That explains why, in mass housing projects or single dwellings, over 3,000,000 are in service in such systems today.

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Dept. GO-4, Morton Grove, Illinois
Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario

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LOW OPERATING COST. The heat exchanger is engineered for low static pressure . . . permits moving more cfm per hp.

LONGER LIFE. The exclusive Tri-Alloy heat exchanger resists corrosion from extreme temperatures, moisture and flue gases.

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Johnson Temperature & Air-Conditioning Control Sets the Pace...

PUT THE ACCENT ON EFFICIENCY!

At left is a console-type Johnson Pneumatic Control Center installed in the National Bank of Detroit. Albert Kahn Associated Architects & Engineers, Inc. Panel at right is installed in the First Presbyterian Church, Elkhart, Indiana. Wiley & Miller, architects; Bevington, Taggart & Fowler, mechanical engineers.

JOHNSON PNEUMATIC CONTROL CENTERS provide the convenience and economy of centralized supervision and control of air conditioning at a lifetime cost unmatched by other types of control. *The instrumentation is as simple, trouble-free, and dependable as the pneumatic controls used elsewhere in a building!* And exclusive operational features compound the savings! Each panel is custom planned to meet the specialized needs of the individual building. Ask your local Johnson representative to explain in detail how Johnson Pneumatic Control Centers can add to the efficiency of your clients' buildings. Johnson Service Company, Milwaukee 1, Wisconsin. 105 Direct Branch Offices.

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TO MANUFACTURE
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completely self-contained air conditioning units

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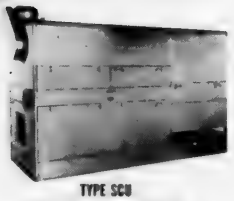
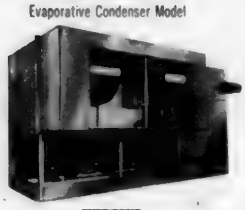
. . . began the manufacture of the first completely self-contained commercial type air conditioning units in 1937. Development has been continuous since that time, and Governair now manufactures packaged air conditioning units, for both commercial and industrial application, in the widest range of capacities available in the industry.

Governair Corporation also constantly recognizes the importance of producing a high quality, completely flexible system to benefit the end user best. Production facilities are tailored to accomplish these ends economically. This, in turn, makes the Governair prices highly competitive, even though only the finest components are used in the assembly.

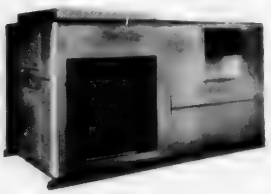
Development of the larger tonnage units has made available the economy of installation and reliability of a factory balanced and tested package system . . . for even the largest industrial requirements. Single units of 120 ton capacity are being fabricated regularly — and to the exact specifications of the customer.



TYPE SCU
Evaporative Condenser Model

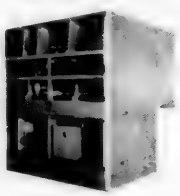


TYPE SCMZ
Complete Multi-Zone Package



TYPE SCAC
Air Cooled Condenser

TYPE ST
Water Cooled Model



TYPE STMZ
Water Cooled Multi-Zone

GOVERNAIR CORPORATION
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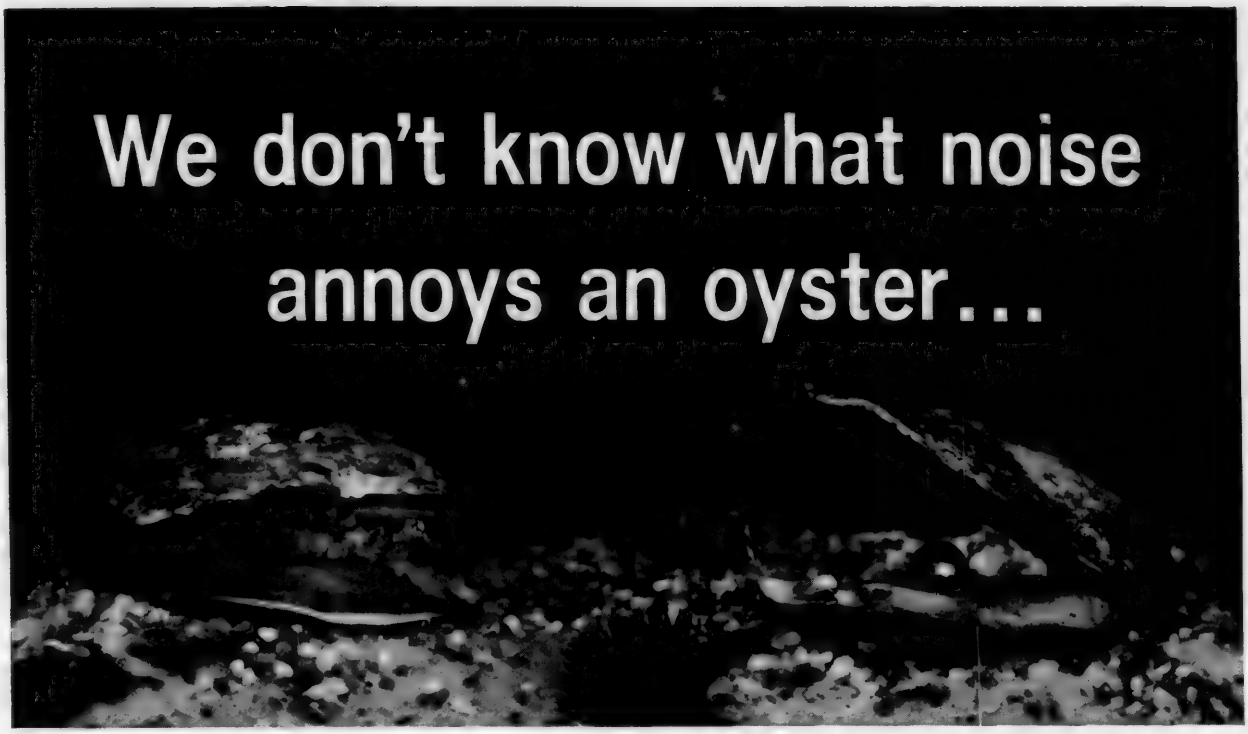
We don't know what noise annoys an oyster...



. . . but we do know plenty about eliminating *industrial* noise. Koppers AIRCOUSTAT is the *pioneer product* for controlling duct-transmitted noise in air handling systems . . . and Koppers has the *longest, broadest experience* in the whole field of industrial sound control, from air conditioning to aircraft engines.

AIRCOUSTAT® is the quality standard in its field. Its pioneer engineering is matched by premium construction that features heavier gauge metal than competitive units. It is assembled with care to give the quality performance promised by its original design. And AIRCOUSTAT provides *guaranteed* attenuation certified in the laboratories of independent research organizations.

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You pay no more for unequalled SLOAN quality...

5 good reasons WHY your choice should be ROYAL

The Sloan ROYAL Flush Valve is the standard of comparison by which all other flush valves are judged. Only the ROYAL provides all of the quality features demanded in modern flush valves, which are—

Segment Diaphragm • Natural rubber vulcanized to brass reinforcements affords added strength and provides extra-long service life

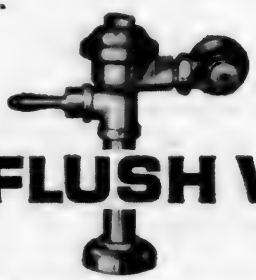
Inside Cover • Not only protects, but controls the flexing action of the diaphragm—while in cooperation with the outside cover, it makes a stronger union of both body and cover

No regulation • A uniform flush every time with nothing to get out of order, means service and water economy you can take for granted

Non-hold-open • A Sloan Royal will complete its cycle and shut off automatically, whether the handle is held or released—another important water saving feature

Double-handle openings • Concealed Royals rough-in either right hand or left hand. This flexibility solves unforeseen problems on the job

These are the quality features which account for the ROYAL's overwhelming popularity, and sustain its leadership as the Flush Valve of universal preference. They are further examples of that bonus of quality you expect from Sloan. And, since you can have Sloan quality at no extra cost, why not make sure you get it.



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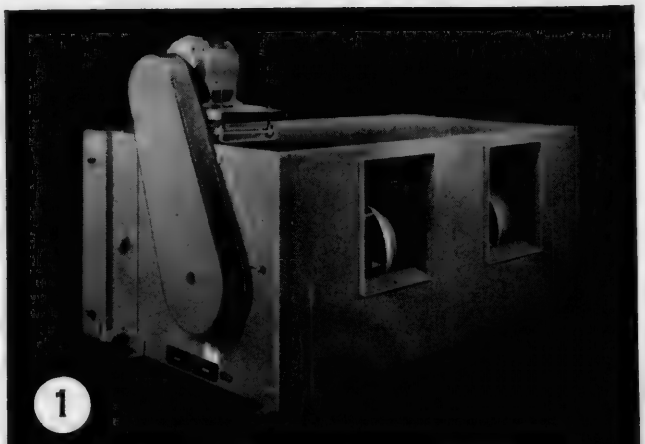

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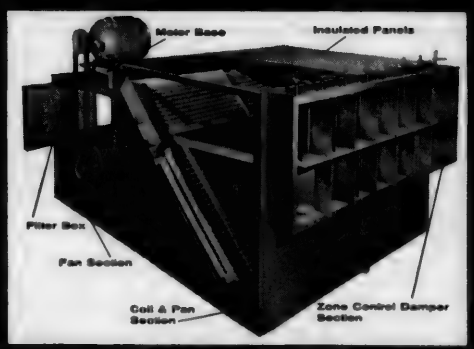

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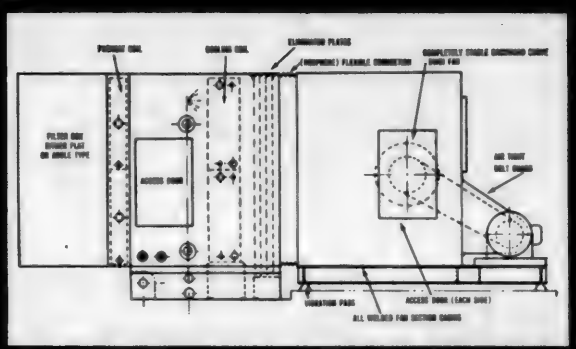

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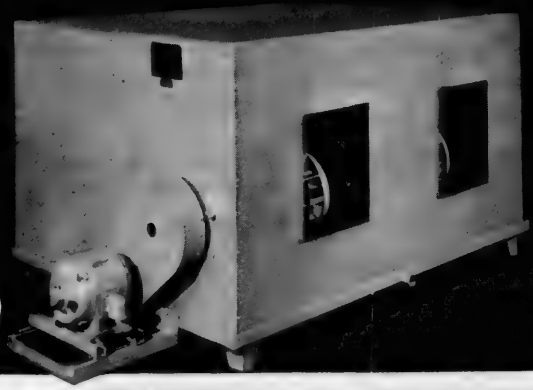

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Air conditioning performance proved beyond question!

Complete selection to meet specifications exactly!

Start with your simplest heating and ventilating requirements and proceed to the most complex conduit system. There's a 'Buffalo' Cabinet or combination of cabinets to deliver the exact air conditions called for in the plans. 'Buffalo' continues to develop new equipment to meet the most rigorous demands. You are assured of performance-as-specified whenever you write 'Buffalo' into the plans.

Check these quality 'Buffalo' engineering features:

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- Heavy-gauge panel casings, galvanized and primed. Rigid, husky frames.
- Quality Aerofin coils for efficient heat transfer and long, trouble-free life.
- Vertical or horizontal installation.
- Many options — filter sections, mixing boxes, dampers and 'Buffalo' 45° and 90° stationary or adjustable outlet elbows.

Your 'Buffalo' Engineering Representative can give you complete information on equipment for any application.

1 For Heating and/or Ventilating — 'Buffalo' H & V Cabinets.

2 For Zone Control Air Conditioning — PCB Cabinets.

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Buffalo, New York

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'Buffalo'

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

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THIS NEW VACUUM HEATING PUMP IS SIZED TO ACTUAL JOB REQUIREMENTS

It's the Nash CSM

No longer is it necessary for the Engineer to accept a vacuum heating pump with air and water capacities based inflexibly upon square feet of equivalent direct radiation. With the flexible Nash CSM he can provide for proper air capacity in accordance with his judgment and experience. For the individual capacities of the separate pumps on the CSM may be varied within a wide range, without buying an oversize receiver and oversize water pumps.

These pumps possess many other features which permit a more efficient utilization of fuel and minimum use of electric power. Low, low, returns reduce installation costs and usually eliminate putting the pump in a pit. Simplicity and efficient operation reduce supervision and maintenance costs. Information regarding this new heating pump development is available immediately upon request.

- Increased air capacity induces rapid system response without wasteful overheating.
- Separate air and water pumps individually selected to meet actual job requirements.
- Control system that operates individual pumps only when needed.
- Flexibility permitting addition of radiation without changing basic pump installation.
- Low, low, return line connection.

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Hydraulics of Tall Buildings

S. DARYANANI

Professional Engineer

New York, N. Y.

How can chilled water systems be split so that pressures will be held down to within the range of standard equipment?

THE PHYSICAL HEIGHT of a multi-story building is one of the most important factors involved in design and selection of air conditioning systems best suited for this type of application.

With the increase in the height of a building, there is a corresponding increase in the height of water column or hydrostatic pressure on the distribution system. Besides, the distribution system itself will need a more extensive piping network which will call for a corresponding increase in the dynamic pressure required for circulation of the water through the system. Consequently, total system working pressure, the sum of dynamic and hydrostatic pressures, will increase substantially due to the increase in the height of the building.

Maximum total working pressure might occur at the lowest point in the system and all the equipment located at that level will have to be strong enough to withstand,

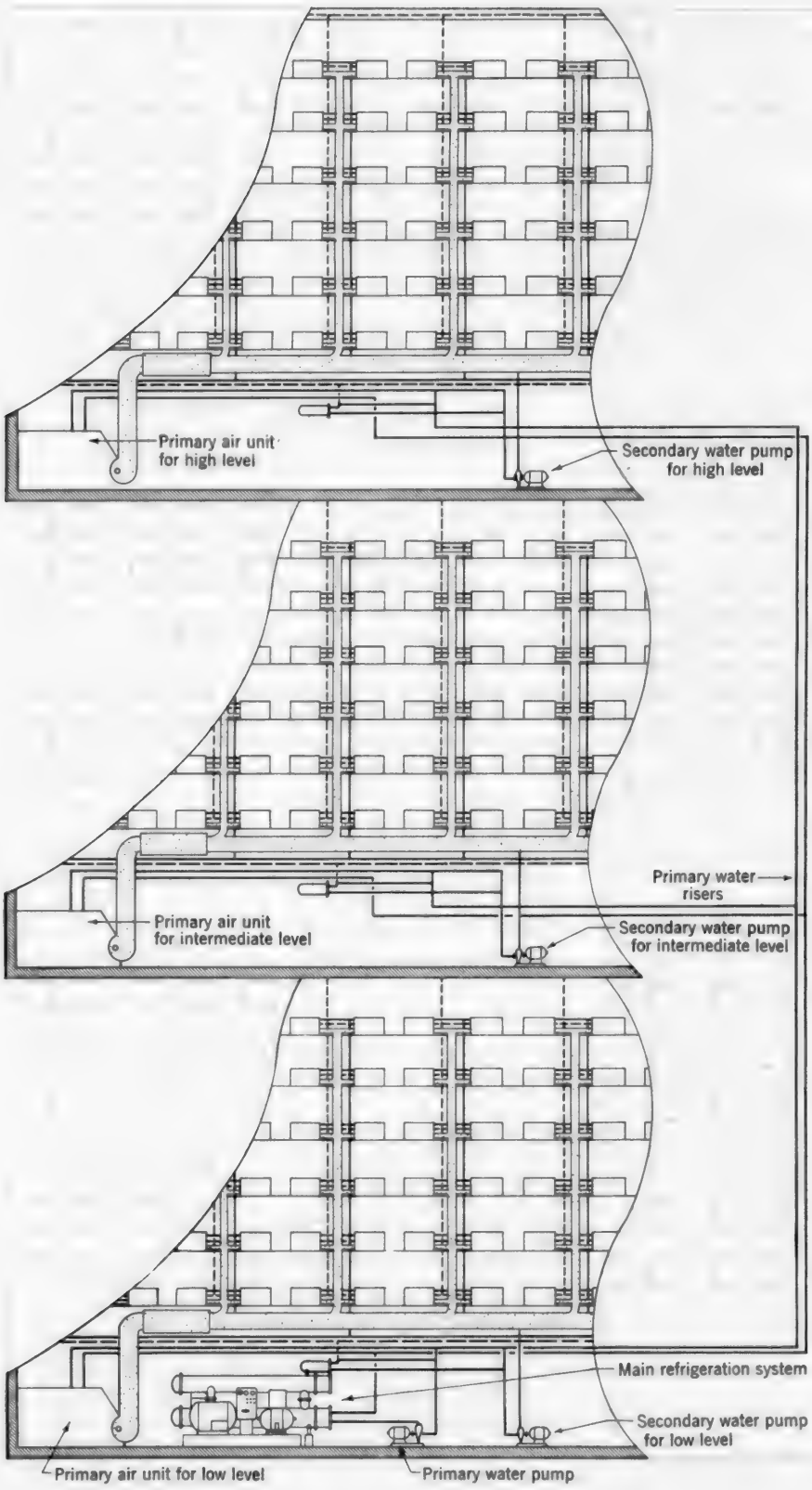
Primary air unit for high level
Secondary water pump for high level
Primary water risers
Primary air unit for intermediate level
Secondary water pump for intermediate level
Main refrigeration system
Secondary water pump for low level
Primary air unit for low level
Primary water pump

Fig. 1. Typical multi-story building. Main refrigeration equipment is installed in basement. Three secondary water circuits serve air conditioning system, split vertically.

safely, this working pressure. At the intermediate levels, working pressure will be lower and equipment at these levels need be designed only for the corresponding pressure.

Since the higher the design pressure, the more expensive the system, the object of analysis should be not only to determine working pressure at different levels, but to arrange the system in such a manner as to limit the maximum working pressure within the range of standard equipment, thereby reducing the cost of installation.

General Arrangement of Equipment

A typical multi-story building, Fig. 1, has its main refrigeration equipment installed at the lowest level, usually the basement. The interior zone is handled by an all air system, while the exterior zone, which is subject to variable loads, is better handled by an air and water system, usually induction units on the perimeter of all the floors. The building may be further divided vertically into groups of floors, each group having a separate mechanical equipment room for the air handling units for the interior zone and the primary air units for the exterior zones of the floors within that group.

Primary chilled water for all the air handling units of the building is supplied by the refrigeration unit in the basement. The water circulation system for the induction units, the secondary water system as it is often called, may be either one continuous system from the ground floor to the top floor of the building or a number of separate and independent systems, divided in the same manner as the air handling units for the different groups of floors.

Pressure Analysis

A pressure analysis of a typical primary water riser diagram for a multi-story building is shown in Fig. 2. Following is the information on which the pressure analysis is based:

1. An open expansion tank has been connected to the system at point *A*, the point of least pressure. Elevation of the tank is 10 ft above point *A*, therefore the hydro-static pressure at this point is 10 ft of water.

2. Pressure drop due to friction of the system between points *A* and *B* has been calculated and found to be 40 ft of water. This pressure drop includes the topmost cooling coil, together with all such accessories as automatic control valve, balancing valve, isolating valve, piping and fittings.

3. Total working pressure at point *B* is 40 + 10 = 50 ft of water.

4. Floor-to-floor height of the building is 13′-0″.

5. The water supply riser was designed for an average frictional pressure loss of 7.5 ft of water for 100 ft length. Therefore, pressure loss for each floor will be 7.5/100 × 13 = 0.975 ft, or approximately 1 ft of water.

6. Total gain in working pressure per floor = hydrostatic head + pressure loss due to friction = 13 +1 = 14 ft of water.

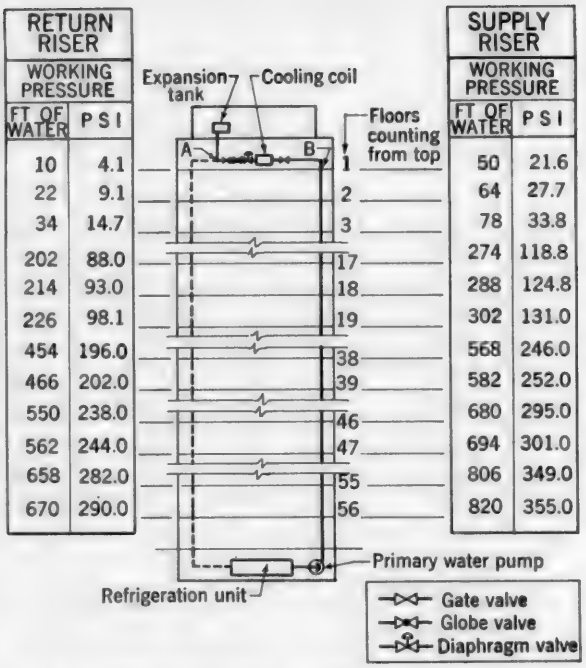

Fig. 2. Pressure analysis of a typical primary water riser diagram for a multi-story building. Pressures are tabulated to help in specifying equipment.

7. Total working pressure at second floor from the top = 50 + 14 = 64 ft of water.

In this manner, total working pressure can be tabulated for each floor of the building so that equipment at each level can be specified to withstand the corresponding pressure.

Pressure Class

Equipment is generally designed and specified for the following working pressures: 125/150 psi, 250 psi, 300 psi, and 350 psi.

As seen from the Fig. 2, in this case 125-psi class equipment can be used only to the 18th floor, counting the floor numbers down from the top floor of the building; 250-psi class equipment will be required from the 19th to 38th floors; 300-psi class from the 39th to 46th floors; and 350-psi class from the 47th to 55th floors.

Effect On Secondary Water Systems

In practice, the pressure analysis is slightly complicated by the presence of the secondary water system, a typical arrangement for which is shown in Fig. 3.

Pressure at point *Y* will be equal to the pressure at point *Z*, the working pressure of the primary water system, less frictional pressure loss for piping and the valves between points *Y* and *Z*. Working pressure at point *X* is equal to the pressure at point *Y* plus dynamic pressure developed by the pump to overcome frictional loss of the secondary water system. In most cases, working pressure of the secondary water system at point *X* will be substantially higher

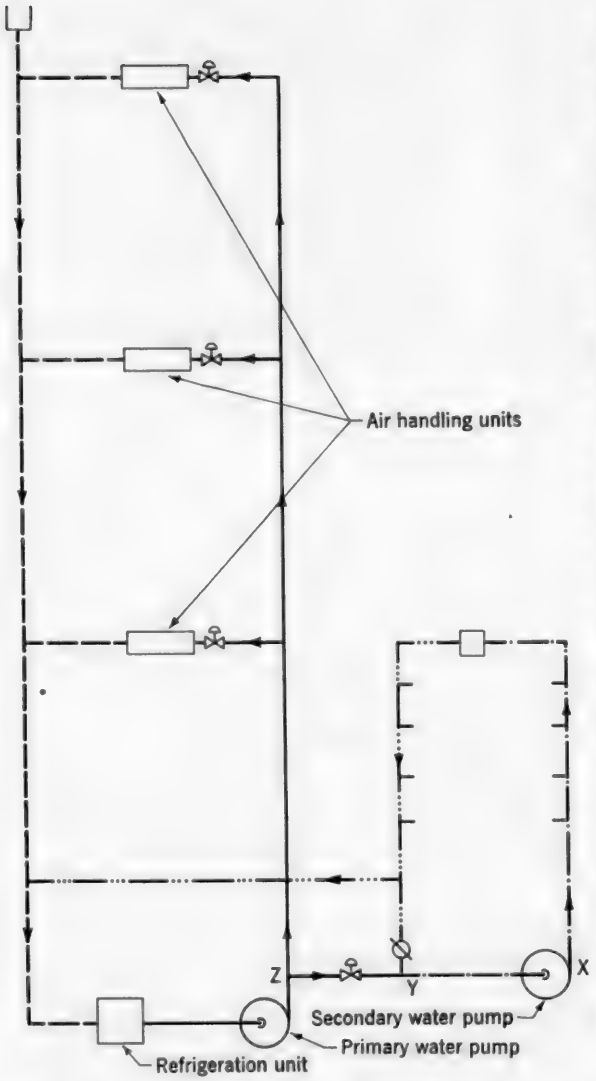

Fig. 3. Secondary water system complicates pressure analysis. In most cases, pressure at X will be substantially higher than at Z.

than the working pressure of the primary water system at point *Z*.

Besides higher working pressure, the secondary water system invariably operates on temperatures as high as 200 deg F to provide gravity heating during the winter season. The combination of high working pressure and high temperature affects adversely the pressure rating of the system.

The problem is further complicated by the fact that the essential components of the secondary water system, induction unit cooling coils and automatic control valves, are normally made for a maximum working pressure of 250 psi, and equipment for higher working pressures being non-standard, will entail extra charges. Since even a small multi-story building may have a few hundred induction units and control valves, even an insignificant extra charge multiplied by that number of units will amount to a substantial sum. It is therefore essential that the primary water system should be designed in such a way that the working pressure will be as low as possible, and in any case, that the working pressure of the secondary water system be limited to the maximum of 250 psi.

Locating Equipment for Minimum Pressure

All equipment on the discharge side of the water circulating pump must be able to withstand the total working pressure, which is equivalent to the hydrostatic pressure plus the frictional pressure drop up to the point of least pressure, as shown by the pressure analysis in Fig. 2. Similarly, working pressure on the suction (return) side of the pump will be equal to the difference between the hydrostatic pressure and the frictional pressure drop from the point of least pressure. In other words, when the pump is operating, the working pressure on the suction side will be much lower than the hydrostatic pressure which will normally exist in the system. Therefore, equipment connected on the suction side of the water circulating pump shall be designed for system hydrostatic pressure only.

In a multi-story building where the main equipment is installed at the lowest level, the chiller and condenser are best installed on the suction sides of their respective pumps so that such components as tubes, tube sheets and water boxes are specified for the hydrostatic pressure only. The pump casing, discharge piping, and equipment connected on the discharge side (normally, the cooling coils and secondary water system) will have to be designed for the maximum working pressure.

Further reduction in the working pressure can be made by adopting a different system arrangement.

How to Reduce the Working Pressure

There are several ways in which the hydraulic system of a multi-story building can be arranged to limit its working pressure. Three common arrangements are shown in Fig. 4, 5, and 6. The three arrangements shown are essentially the same, since the water circulation system has been separated into completely isolated sections, each section serving a group of floors at different level and consequently, maintaining the pressure in that group within the desired limits. The only differences are in the location of the equipment for the higher levels. Advantages and disadvantages of the three arrangements have to be balanced to arrive at the most economical design.

Arrangement One (Figure 4)

Advantages: All the main equipment is installed at one level, usually the lowest level, making a compact installation, an ideal condition for maintenance and supervision.

Disadvantages: Though working pressures at the higher level and for the equipment at that level may be low, the main equipment at the lowest level will be subject to appreciably higher pressures due to the increased height of the water column. In addition,

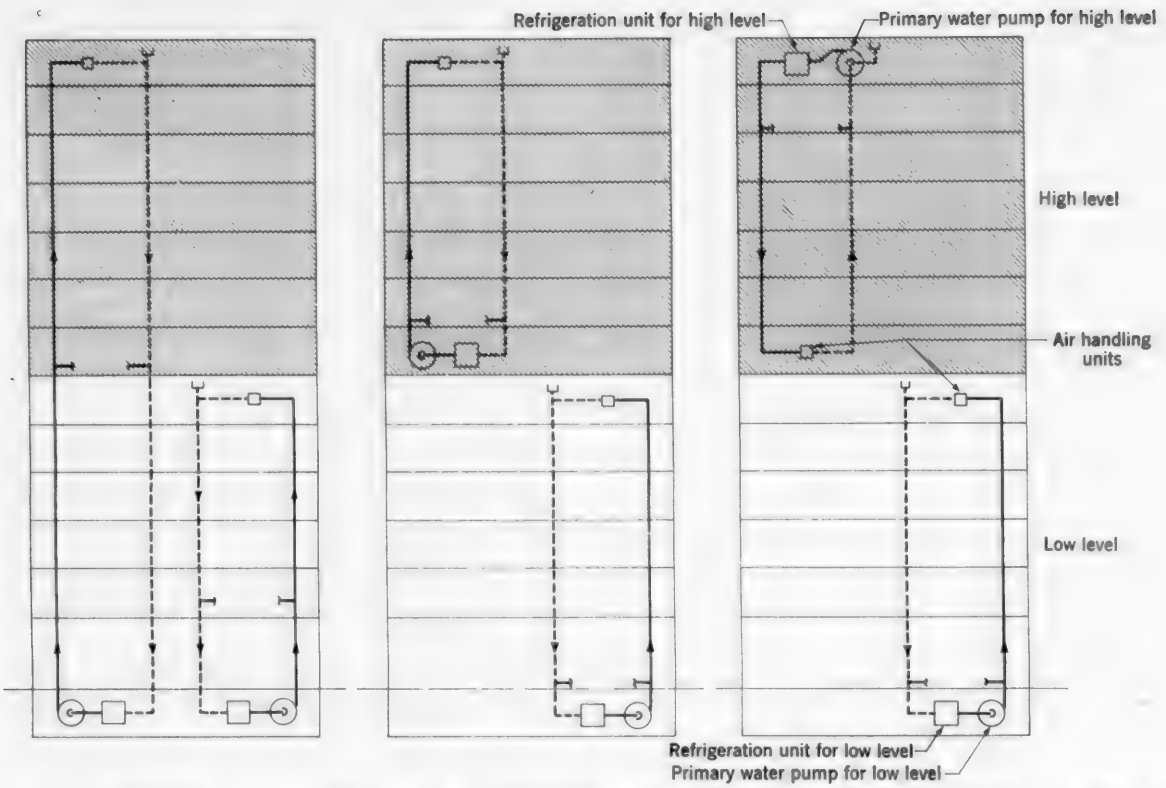
Refrigeration unit for high level
Primary water pump for high level
High level
Air handling units
Low level
Refrigeration unit for low level
Primary water pump for low level

Fig. 4. Arrangement 1. All main equipment installed on one level. This makes supervision easy.

Fig. 5. Arrangement 2. Main equipment near area it serves.

Fig. 6. Arrangement 3. Similar to Arrangement 2, but high-level pump is located at the top.

since equipment at the higher level is separated from the area it serves by almost half the building length, the system will need a long distribution network.

Arrangements Two and Three (Figures 5 and 6)

Advantages: In both cases, the main equipment is installed near the area it serves, therefore the piping system will be compact and economical. The main refrigeration equipment for the high level will not be subject to excessive hydrostatic heads. As a matter of fact, the pressure for the higher level equipment shown in the second arrangement (Fig. 5) will be very small. Further, as the cooling tower is invariably located at the top of the building, installing the refrigeration equipment at the high level will reduce the piping length and the pumping loss of the condenser water circuit.

Disadvantages: Equipment installed at the higher levels will take premium rental space. Rigging expenses will add to the initial cost of the installation. Equipment, being nearer to the occupied areas, might need expensive treatment to reduce transmission of noise and vibration. Finally, since the main equipment is spread out at different levels, it will need more maintenance labor.

Flexibility of Operation

All three arrangements shown in Fig. 4, 5 and 6, have one common disadvantage—lack of flexibility of operation. The stand-by compressor or the stand-by chilled water pump for the low level cannot be utilized for the high level system in case of breakdown, because the two systems, operating at different pressures, cannot be interconnected. Therefore, each system will need separate stand-by equipment resulting in duplication of equipment and adding to initial cost. It is better to air condition the entire building by one central system having the required number of compressors and circulating pumps connected in parallel. Operation-wise, such a system presents several advantages:

1. System can easily withstand overloads. Suppose a building is air conditioned by two separate systems, each half the required capacity. Then, 40% overload on one system will be reduced to only 20% overload if the building is air conditioned by one central system equal to the total required capacity.

2. In case of a single central system, a better diversity factor can be utilized, thereby reducing size and the initial cost of the equipment.

3. Only one set of stand-by equipment is required, eliminating duplication. Even if stand-by equipment is not provided, loss of part of the cooling system spread over the entire building will produce very little hardship.

4. Since a number of compressors and chilled water pumps are connected in parallel, it would be advantageous to have all the units of the same size and type. By so doing, inventory of spare parts can be reduced.

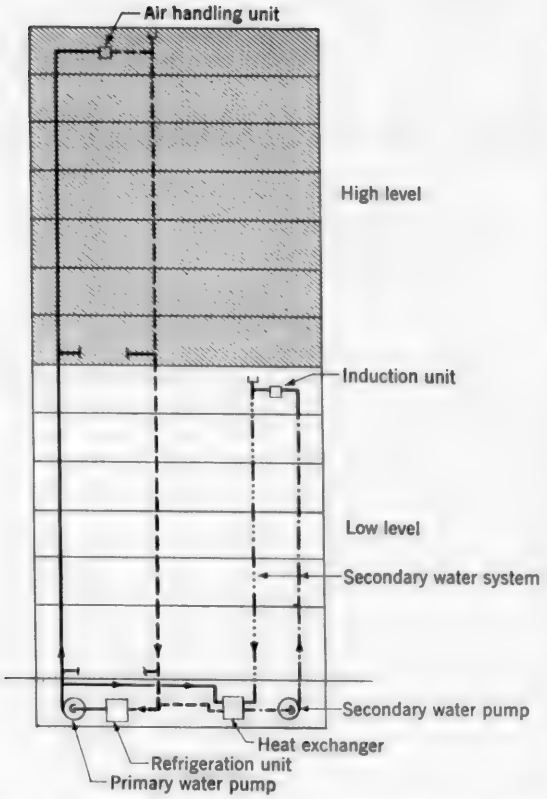

Fig. 7. Hydraulically separate secondary water system is linked to primary system through heat exchanger, which may have to have excessively large surfaces.

When equipment is separated to meet pressure limitations, it might not be possible to have identical equipment for two levels.

5. Installation of equipment at one location makes maintenance and supervision easier.

If this arrangement is adopted, the primary water circuit at the lowest level will have to be designed for the maximum pressure at that lowest level, which, in case of a fifty-story building, may be as high as 350 psi. However, the secondary water system has to be kept within the limit of 250 psi. This can be accomplished by providing a separate and isolated secondary water system for the lower levels.

Hydraulically Separate Secondary Water System

In order to reduce the pressure on the secondary water system, it is necessary to isolate it hydraulically from the primary water system. Pressure of the secondary water system will then be independent of the pressure in the primary water system, depending only on the height of the secondary water system and the pressure required to circulate the water through the system. The working pressure of the secondary water system can then be limited by reducing the height or the number of floors served by each system.

The cooling load on the secondary water system, as shown in Fig. 7, is still provided by the primary water system, though indirectly, through a heat exchanger between the two circuits, forming a thermal connection instead of a hydraulic connection. This arrangement is made feasible by the fact that the secondary water system does not need chilled water at so low a temperature as that required for the primary water system and therefore can afford to stand the rise of temperature caused by the heat transfer operation. Since all cooling and dehumidifying of primary air is carried out by the primary water system, that system requires chilled water in the range of 40 to 45 deg. On the other hand, the secondary water system does sensible cooling only and therefore can be designed to use water ranging from 52 to 58 deg.

The heat exchanger for this type of application will be of the shell and tube type. The primary water circuit, being under high pressure, can be more economically confined to the tubes, the shell being used for the passage of secondary water. The ideal heat transfer arrangement is a counterflow process, but in the case of a shell and tube heat exchanger it is difficult to get true counterflow. Therefore, the heat transfer operation becomes somewhat less efficient. In addition, the temperature potential is very small. For these reasons, the heat exchanger needs enormous heat transfer surface, making it a large and expensive item.

Effect of Working Pressure on Circulating Pump

Most of the components affected by the pressure in the system: piping, fittings, valves, tubes for the chiller, tube covers or water boxes, primary air cooling coils, etc., do not require any change in their functional design except that physically they have to be heavy enough to withstand safely the maximum working pressure to which they are subjected. In the case of the circulating pump, the effect is somewhat different. Of course, the pump casing will have to be designed for the maximum working pressure, but the shaft seal presents a different problem. With the increase in the hydrostatic pressure, the pump will need a packing gland which can hold the shaft tighter and this would mean:

1. The pump shaft or shaft liner will wear out faster.

2. The gland packing will also wear out at an accelerated rate.

3. Because of the added friction on the shaft, the pump will need more power. The problem may be acute at starting time when a high-starting-torque motor may be required to start against the holding friction of the gland.

4. The pump shaft will have to be made stronger to withstand the high starting torque.

Because of these disadvantages, there is an economic limit for which the stuffing box can be used and most manufacturers will recommend a mechanical seal for hydrostatic pressure of more than 150 psi. However, quite a few maintenance men are prejudiced against mechanical seals for they say that this type of seal is not as reliable as the packing gland, since it can fail at any time without the slightest warning. However, till a better solution is found, the system having hydrostatic pressures above 150 psi will need pumps with mechanical seals.

STEP-BY-STEP PROCEDURE TO

Determine Evaporator Capacities

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Herein is presented a direct method for determining the cooling and dehumidifying capacities of a direct expansion evaporator. Physical characteristics of the evaporator, entering air conditions, air flow rate, and refrigerant evaporating temperature are the only predetermined data necessary to complete the calculation.

The method, outlined for plate fin type coils with Refrigerants 12 or 22 evaporating within the tubes, is easily adapted to other fin configurations and refrigerants. The method may also be applied to water coils by considering successive portions of the coil rather than the coil as a whole.

A brief theoretical explanation of the method is followed by an outline of the method itself. Following is a practical illustrative example.

THE HEAT TRANSFERRED from the air stream to the wet coil surface is equal to the heat transferred from the wet coil surface to the inner fluid, or

$$q_o = q_i \qquad (1)$$

The heat transferred from the air stream to the wet coil surface is given by

$$dq_o = -Gdh_a = (f_a/C_p)(h_a - h_s)dA_o \qquad (2)$$

This equation, originally derived by Merkel[1], combines latent heat transfer due to the vapor pressure difference and sensible heat transfer due to the vapor temperature difference, and states that the simultaneous latent and sensible heat transfer rate depends on the difference between the total heat of the air flowing over the surface and the total heat corresponding to saturation at the surface temperature.

Heat transferred from the wet coil surface to the inner fluid is given by the following equation, for constant t_r and t_s:

$$q_i = (A_o/R)(t_s - t_r) \qquad (3)$$

Equation (2) can be readily integrated if it is assumed that surface temperature remains constant over the surface. Coil surface temperature actually varies from row to row and from fin root to fin tip. However, use of this assumption greatly simplifies the calculations and results in reasonable values for overall coil capacity.[15] Upon integration, equation (2) becomes

$$q_o = G(h^e_a - h_s)(CF) \qquad (4)$$

in which the substitution of CF, called the coil contact factor, for the quantity $[1 - \exp(-f_a A_o/C_p G)]$ simplifies the equation.

Substitution of equations (3) and (4) in equation (1), and rearranging the result,

$$\frac{(CF)(G)(R)}{A_o} = \frac{t_s - t_r}{h^e_a - h_s} = K \qquad (5)$$

The value K, derived by Kusuda[2], is called the *coil characteristic* since it contains all the physical characteristics of a given fan-coil. Fig. 4 is a series of direct-reading curves for the solution of equation (5), obtained by plotting $Kh_a^e + t_r$ vs. t_s for parameters of K. A practical procedure for determination of K will be given, also. While others[3, 4] have presented solutions in this area, it is believed that the present method results in the fastest and most direct procedure for finding total coil capacity.

Once surface temperature and its corresponding enthalpy have been determined from equation (5), they may be substituted back into either equation (3) or (4) to determine total wet coil capacity, or

$$Q_T = G(h_a^e - h_s)(CF) = (A_o/R)(t_s - t_r)$$

Sensible coil capacity is then given by

$$Q_S = C_p G(t_a^e - t_s)(CF)$$

Dry Coil Capacity

If t_s, determined from equation (5) is found to be greater than the entering air dew point, the coil surface will operate dry; that is, the latent heat capacity of the coil will be zero. Coil surface temperature, therefore, will not be at t_s, since this was determined on the basis of a wet coil surface, but rather at some new value, t_s'. It can be shown that the total dry coil capacity is

$$Q_{dry} = C_p G(t_a^e - t_r)(CF')$$

where CF', the dry-coil contact factor $= 1 - \exp(-UA_o/C_p G)$ and $U = f_a/(Rf_a + 1)$.

Calculation of K

The coil characteristic, K of equation (5), is a function of A_o, G, CF, and R.

A_o, total external coil surface area in square feet, is the sum of the primary (tube) and secondary (fin) surfaces of the coil. It will be assumed that the fin collars which exist on plate fin type coil construction form an integral bond with the tube surface. The collars therefore will be considered as primary, rather than secondary, surface, so that (see Fig. 1)

$$D_o = OD + 2\delta$$

$$S_F = \frac{(S_1 S_2 - \tfrac{1}{4}\pi D_o^2)(2)(m \times 12)}{144} = (m/6)(S_1 S_2 - \tfrac{1}{4}\pi D_o^2)$$

$$S_P = \frac{\pi(D_o)(1)}{12} - \frac{\pi(D_o)(1)}{12}(m\delta) =$$

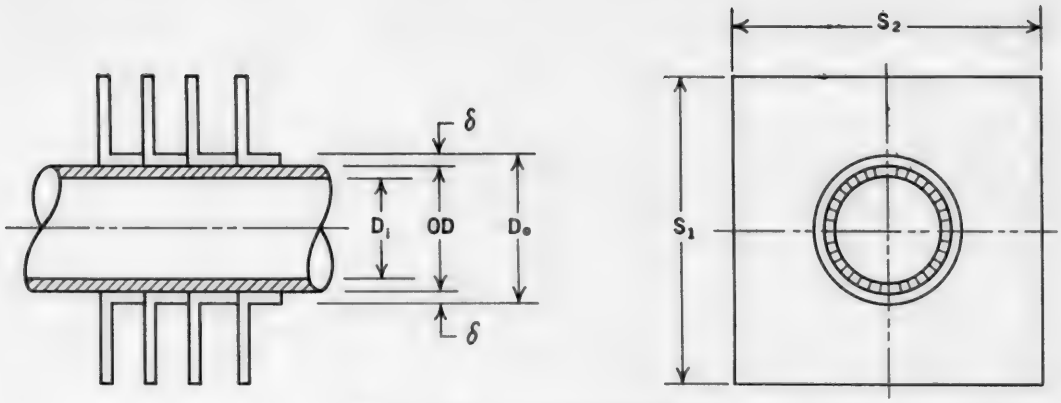

Fig. 1. Diagram of finned tubing.

DEFINITION OF SYMBOLS USED

A_o = Total external coil surface area, sq ft
CF = Wet coil contact factor, dimensionless
CF' = Dry coil contact factor, dimensionless
CFM = Air volume flow rate, cfm standard air
C_p = Specific heat of air, Btu per (lb) (deg F)
D_i = Tube inside diameter, inches
D_o = OD + 2 δ
DP^e = Entering air dew point, deg F
f_a = Air film heat transfer coefficient, Btu per (hr) (sq ft) (deg F)
f_i = Inner fluid (refrigerant) heat transfer coefficient, Btu per (hr) (sq ft) (deg F)
f_w = Water film heat transfer coefficient, Btu per (hr) (sq ft) (deg F)
G = Air mass flow rate, lb per hr
H = Coil fin height, inches
h_a^e = Entering air enthalpy, Btu per lb
h_a^l = Leaving air enthalpy, Btu per lb
h_s = Enthalpy of saturated air at the coil surface temperature, Btu per lb
K = Coil characteristic, dimensionless
k_m = Fin metal thermal conductivity, Btu per (hr) (sq ft) (deg F) per ft
L = Coil finned length, inches
LHF = Latent heat factor, dimensionless
m = Number of fins per inch
n = Number of rows deep
N = Number of tubes high
OD = Tube outside diameter, inches
q_i = Heat transferred from wet coil surface to inner fluid, Btu per hr
q_o = Heat transferred from air stream to wet coil surface, Btu per hr
Q_{dry} = Total dry coil capacity, Btu per hr
Q_s = Sensible wet coil capacity, Btu per hr
Q_T = Total wet coil capacity, Btu per hr
R = Overall heat transfer resistance from inner fluid to outside coil surface, (hr) (sq ft) (deg F) per Btu
r_f = Fin-tube joint heat transfer resistance, (hr) (sq ft) (deg F) per Btu
r_m = Fin metal heat transfer resistance, (hr) (sq ft) (deg F) per Btu
r_o = Refrigerant oil heat transfer resistance, (hr) (sq ft) (deg F) per Btu
r_t = Tube heat transfer resistance, (hr) (sq ft) (deg F) per Btu
S = Total coil surface per foot of tube, sq ft per ft
S_F = Secondary coil surface per foot of tube, sq ft per ft
S_P = Primary coil surface per foot of tube, sq ft per ft
S_1 = Tube center distance (normal to air flow), inches
S_2 = Row center distance (parallel to air flow), inches
t_a^e = Entering air dry bulb temperature, deg F
t_a^l = Leaving air dry bulb temperature, deg F
t_r = Refrigerant evaporating temperature, deg F
t_s = Wet coil surface temperature, deg F
t_s' = Dry coil surface temperature, deg F
U = Overall heat transfer coefficient from inner fluid to outside air stream, Btu per (hr) (sq ft) (deg F)
V_F = Air face velocity, ft per min
w = Equivalent circular fin width, ft
WB^e = Entering air wet bulb temperature, deg F
X_e/X_b = Dimensionless parameter for determining ϕ
y = Dimensionless parameter for determining CF
y' = Dimensionless parameter for determining CF'
δ = Coil fin thickness, inches
ξ = Dimensionless parameter for determining ϕ
τ = Ratio of external to internal surfaces, dimensionless
ϕ = Coil fin efficiency, dimensionless

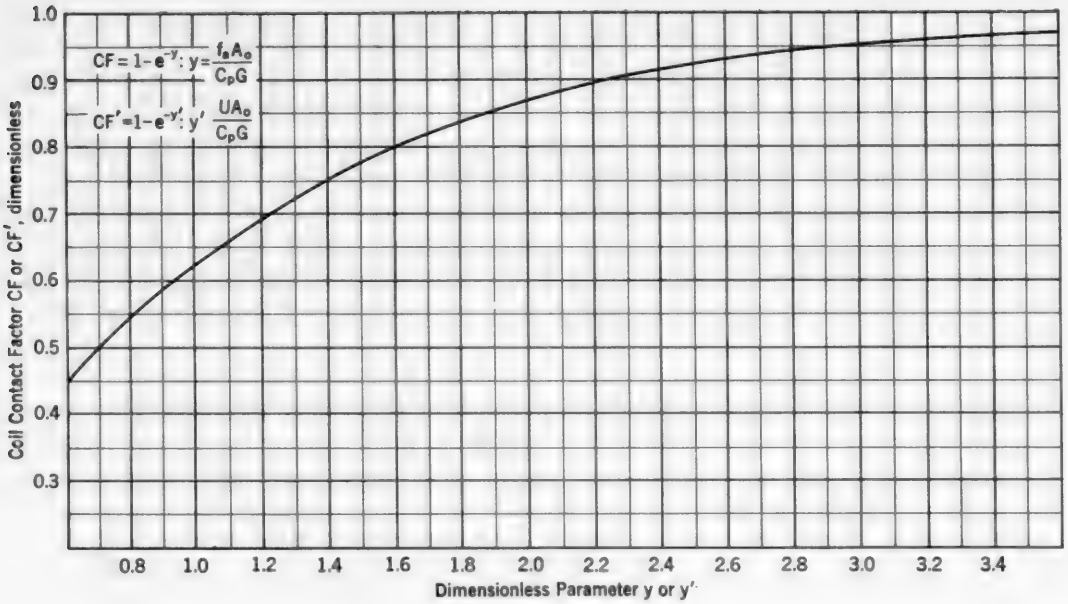

Fig. 2. Contact factor.

$$\frac{\pi D_o}{12}\,(1 - m\delta)$$

$S = S_F + S_P$

where S_F = square feet of secondary surface per foot of tube,

S_P = square feet of primary surface per foot of tube, and

S = square feet of total surface per foot of tube.

Therefore,

$$A_o = S(L/12)(N)(n).$$

G, the air mass flow rate, in pounds per hour, is

$$G = (CFM/v)60$$

Where v = 13.33 cu ft per lb (standard air),

$$G = (CFM/13.33)\,60 = 4.5\ CFM, \text{ and}$$

$$C_pG = (0.24)(4.5\ CFM) = 1.08\ CFM$$

CF, the dimensionless coil contact factor, is by definition,

$$CF = [1 - \exp(-f_aA_o/C_pG)]$$

A_o and G have been determined previously. The air film heat transfer coefficient, f_a, is basically a function of the coil configuration and Reynolds number. Analyses of available empirical data in this area indicate that Kays and London[5], Grimison[6], and Holladay[16] provide essentially the same values for f_a over the normal air conditioning range. In addition, performance tests run at Worthington Corporation on a wide variey of plate fin coils have been compared with calculated results based on the Grimison data.

The foregoing comparisons indicate that Grimison data, while originally determined for bare tube configurations, may be applied to plate fin coils, if: (1) the calculations are based on face velocity, V_F and tube outside diameter, OD; (2) the ratio of coil minimum free-flow area to face area, $\frac{A_N}{A_F}$, is in the range of 0.50 to 0.65; and (3) the face velocity, V_F, is in the range of 300-800 fpm.

There is, as yet, no justification for the use of these data beyond these ranges. However, the large majority of air conditioning applications of plate fin coils fall within these limitations.

For convenience, values of f_a (Grimison) for the more common tube diameters are listed in Table 1. Knowing f_a, CF can be found from the curve in Fig. 2, which is a plot of CF vs. y and CF' vs. y', where

$$y = f_a A_o/C_pG$$

$$y' = U A_o/C_pG$$

TABLE 1—AIR FILM COEFFICIENT

Air Film Heat Transfer Coefficient, f_a, Btu per (hr)(sq ft)(deg F)

Air Face Velocity, V_F, Ft per Min	Tube Arrangement				
	In-Line			*Staggered*	
	Tube Outside Diameter				
	½	⅝	⅜	½	⅝
300	8.0	7.2	10.8	9.5	8.6
350	8.8	8.0	11.8	10.4	9.4
400	9.6	8.7	12.7	11.2	10.1
450	10.3	9.4	13.6	12.0	10.8
500	11.0	10.0	14.5	12.7	11.5
550	11.7	10.6	15.3	13.4	12.2
600	12.4	11.2	16.1	14.0	12.8
650	13.0	11.8	16.9	14.6	13.3
700	13.6	12.4	17.7	15.2	13.8
750	14.2	12.9	18.4	15.8	14.3
800	14.8	13.4	19.0	16.4	14.8

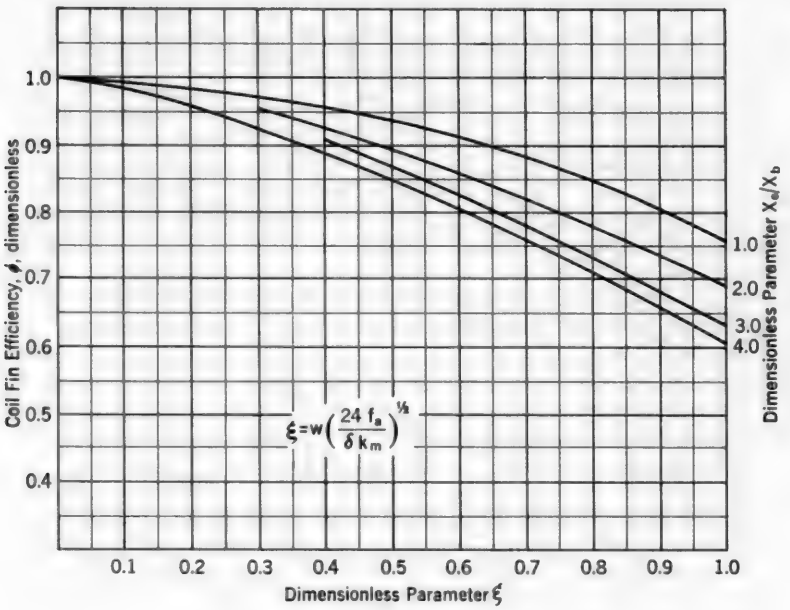

Fig. 3. Fin efficiency.

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R, the overall heat transfer resistance from inner fluid to outside coil surface, in (hr)(sq ft)(deg F) per Btu, is

$$R = (\tau/f_i) + r_m + (r_j + r_t + r_o + 1/f_w)$$

where τ = Ratio of external to internal surfaces, $12S/\pi D_i$,
f_i = Inner fluid (refrigerant) film heat transfer coefficient,
r_m = Fin metal heat transfer resistance,
r_j = Fin-tube joint heat transfer resistance,
r_t = Tube heat transfer resistance,
r_o = Refrigerant oil heat transfer resistance, and
f_w = Water film heat transfer coefficient.

It can be shown[2,7,8,9] that the resistances in the second parentheses above can be neglected without introducing any significant error.

Based on the values cited by Ramsey[9] as a guide to design, considerable experimental data by Ashley[10] and Baker[11] on evaporating Refrigerant 12, and by Baker and Staley[12] on Refrigerant 22, it is reasonable to assume a constant value of $f_i = 300$ Btu per (hr)(sq ft)(deg F) for both Refrigerants 12 and 22 for the normal range of air conditioning applications. The corresponding inner fluid resistance, $1/f_i$, must be multiplied by the ratio of external to internal surfaces, τ, since all thermal resistances must be referred to the same surface.

$$R = (\tau/300) + r_m = (S/79\,D_i) + r_m$$

Carrier and Anderson[13] give the following formula for fin metal resistance, r_m

$$r_m = (1/f_a)[(1 - \phi)/(\phi + S_P/S_F)]$$

This equation was derived for use with dry extended surfaces. It may, however, be applied directly to most wet coil configurations since only a small error is introduced if the effect of condensation on the fins is neglected.

Gardner[14] has presented a series of curves for determining fin efficiency, ϕ, for various fin configurations. The curves in Fig. 3 are based on Gardner's data for circumferential fins of rectangular cross section. Carrier and Anderson have pointed out that a reasonably close approximation of the efficiency of a square or rectangular plate fin is obtained by assuming a flat circular fin of equal area. In Fig. 3, ϕ is plotted against ξ for parameters of X_e/X_b where

$$\xi = w(24\,f_a/\delta k_m)^{1/2}$$

$$X_e/X_b = 1 + (24\,w/D_o)$$

and w = equivalent circular fin width, in feet.

$$S_l\,S_t\,/144 = \pi(w + D_o/24)^2$$

$$w = 1/12[(S_l\,S_t/\pi)^{1/2} - D_o/2]$$

For convenience, values of r_m for the more common coil configurations are listed in Table 2. As may be noted, the minor effect of change in face velocity (between 300 and 800 fpm) on r_m has been neglected in the tabulation. In addition, the table is based on 0.008 inch aluminum fin thickness. A small error is introduced if these data are used for other fin thicknesses. However, since r_m is generally less than 30% of the overall coil resistance, R, the effect of these errors on the final evaporator capacity is extremely small.

R may now be computed and, together with A_o, G, and CF, will determine the value of the coil characteristic, K (equation 5). Fig. 4 will give t_s.

Step-by-step Procedure

Given the following,

L = coil finned length, inches,
H = coil fin height, inches,
N = number of tubes high,
n = number of rows deep,
S_l = tube center distance (normal to air flow), inches,

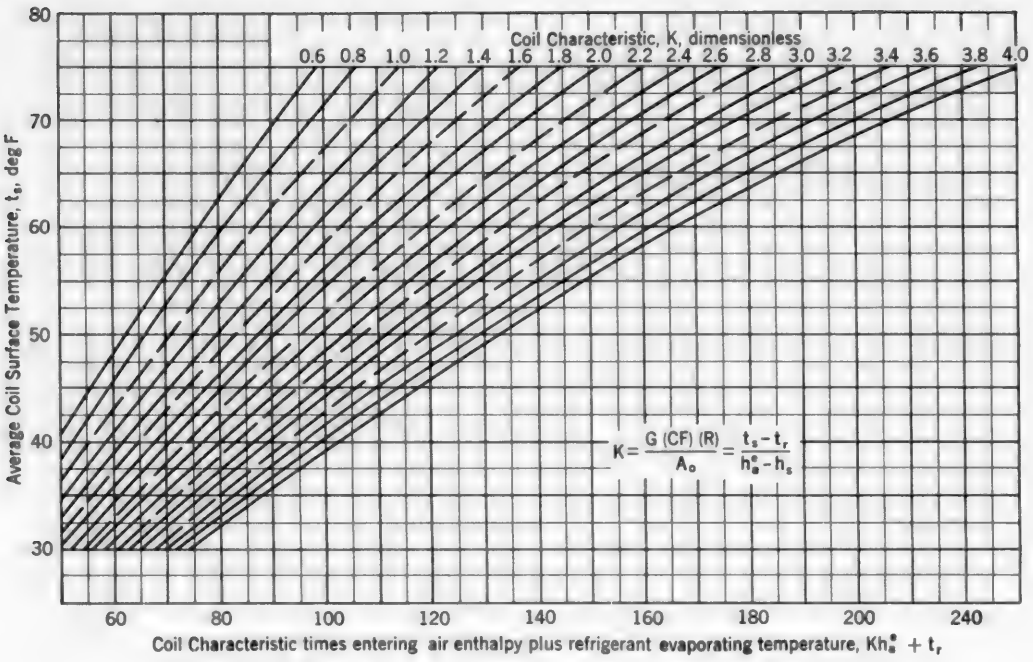
Coil Characteristic, K, dimensionless
0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0
Average Coil Surface Temperature, t_s, deg F
80
70
60
50
40
30
$K = \frac{G\,(CF)\,(R)}{A_o} = \frac{t_a - t_r}{h_a^e - h_s}$
60 80 100 120 140 160 180 200 240
Coil Characteristic times entering air enthalpy plus refrigerant evaporating temperature, $Kh_a^e + t_r$

Fig. 4. Wet coil surface temperature.

S_2 = row center distance (parallel to air flow), inches,
δ = Coil fin thickness, inches,
m = number of fins per inch,
OD = tube outside diameter, inches,
$D_o = OD + 2\delta$
D_i = tube inside diameter, inches,
CFM = air volume flow rate, cu ft per min standard air,
V_F = air face velocity, $144CFM/LH$, ft per min,
WB^e = entering air wet bulb temperature, deg F,
t_a^e = entering air dry bulb temperature, deg F,
DP^e = entering air dew point temperature, deg F,
h_a^e = entering air enthalpy, Btu per lb,
t_r = refrigerant evaporating temperature, deg F, and
Whether tube arrangement is staggered or in-line.

1. $S = (m/6)(S_1 S_2 - \frac{1}{4}\pi D_o^2) + (\pi D_o/12)(1 - m\delta)$
2. $A_o = S(L/12)(N)(n)$
3. Determine f_a from Table 1.
4. $y = (f_a A_o/1.08\,CFM)$
5. Determine CF from curve, Fig. 2.
6. Determine r_m from Table 2.
7. $R = (S/79\,D_i) + r_m$
8. $K = 4.5(CFM)(CF)(R)(1/A_o)$
9. $Kh_a^e + t_r$
10. Determine t_s from curve, Fig. 4.

Wet coil only (t_s less than DP^e)

11. $Q_T = 4.5(CFM)(CF)(h_a^e - h_s)$
12. $Q_S = 1.08(CFM)(CF)(t_a^e - t_s)$
13. $LHF = 1 - Q_S/Q_T$

Dry coil only: (t_s greater than DP^e)

11. $U = f_a/(Rf_a + 1)$
12. $y' = (UA_o/1.08\,CFM)$
13. Determine CF' from curve, Fig. 2.
14. $Q_{dry} = 1.08(CFM)(CF')(t_a^e - t_r)$

TABLE 2—FIN METAL RESISTANCE

Tube Outside Diameter, Inches	Tube Spacing $S_1 \times S_2$*	Heat Transfer Resistance, r_m (hr)(sq ft)(deg F)/Btu
3/8	1.00 × .866	0.0100
	1.00 × 1.00	0.0135
1/2	1.00 × 1.00	0.0085
	1.25 × 1.00	0.0120
	1.50 × 1.50	0.0310
	1.50 × 1.75	0.0400
5/8	1-19/32 × 1 3/8	0.0225
	1.50 × 1.50	0.0235
	1.50 × 1.75	0.0315

*S_1 = Tube center distance, inches, normal to air flow.
S_2 = Row center distance, inches, parallel to air flow.

Illustrative Example

Given the following,

L	= 50 inches	D_o	= 0.528 inches
H	= 22.5 inches	D_i	= 0.474 inches
N	= 18	CFM	= 3,000
n	= 3	V_F	= 384 ft per min.
S_1	= 1.25 inches	WB^e	= 67 deg F
S_2	= 1.00 inches	t_a^e	= 80 deg F
δ	= 0.01 inches	DP^e	= 60 deg F
m	= 10	h_a^e	= 31.62 Btu per lb
OD	= 0.508 inches	t_r	= 40 deg F

Staggered tube arrangement

1. $S = (10/6)[(1.25)(1.00) - \frac{1}{4}\pi(0.528)^2] + (\pi/12)(0.528)[1 - 10(0.01)] = 1.84$ *sq ft per ft*

2. $A_o = 1.84(50/12)(18)(3) = 414$ *sq ft*
3. $f_a = 10.9$ *Btu per (hr)(sq ft)(deg F)*
4. $y = (10.9)(414)/(1.08)(3{,}000) = 1.39$
5. $CF = 0.750$
6. $r_m = 0.0120$ *(hr)(sq ft)(deg F) per Btu*
7. $R = [(1.84)/(79)(0.474)] + 0.0120 = 0.0611$ *(hr)(sq ft)(deg F) per Btu*
8. $K = (4.5)(3{,}000)(0.750)(0.0611)(1/414) = 1.50$
9. $Kh_a^e + t_r = 87.4$
10. $t_s = 53.7$ *deg F* ($h_s = 22.44$ *Btu per lb*) ($\therefore t_s < DP^e$)
11. $Q_T = (4.5)(3{,}000)(0.750)(31.62 - 22.44) =$ 93,000 *Btu per hr*
12. $Q_S = (1.08)(3{,}000)(0.750)(80 - 53.7) =$ 64,000 *Btu per hr*
13. $LHF = 1 - (64{,}000/93{,}000) = 0.31$

Conclusion

The procedures described provide a direct method for determining cooling and dehumidifying capacities of a direct expansion evaporator. Each complete calculation is based on a specific refrigerant evaporating temperature and specific entering air temperatures. Only a small amount of recalculation is necessary to determine coil capacities at other temperature conditions, because the coil characteristic, K, is essentially a function of air flow rate and physical characteristics of the coil only. Actually, the coil characteristic is also a function of air properties such as specific heat, thermal conductivity, specific volume, and absolute viscosity, which do vary with air temperature. Only a small error is introduced, however, if these properties are assumed constant over the normal air conditioning temperature range.[15] The coil characteristic, therefore, remains constant as temperature conditions vary. It is then possible to obtain a complete rating table for a specific evaporator in a relatively short period of time.

In addition, by plotting refrigerant evaporating temperature versus the corresponding total wet coil capacity, it is possible to obtain a "coil line" for this same evaporator, which, when superimposed upon a set of standard compressor capacity lines (usually plotted for parameters of compressor discharge pressure), will yield the balanced refrigerant evaporating temperature and total coil capacity for that specific system.

Using procedures outlined herein, capacities of many direct expansion evaporators at varying temperature and air flow rate conditions have been obtained which, when compared to results with laboratory test runs for the same evaporators at corresponding conditions of service, indicate that calculated values are accurate to within 5% of total coil capacity and to within 8% of sensible coil capacity for sensible heat factors less than 0.90.

Accuracy of calculated sensible coil capacity decreases as the sensible heat factor increases from 0.90 to 1.00, probably due to discontinuities in the condensate film near the "dry coil" region. When operating in this region, therefore, it is recommended that the step-by-step procedure be applied to successive increments of coil (e.g., row by row) rather than to the coil as a whole. Here the coil characteristic per row is assumed constant, and the air temperatures entering each row are set equal to the corresponding temperatures leaving the preceding row. This procedure, which tends to separate the "wet" and "dry" portions of the coil, thus decreasing the error in calculated sensible coil capacity near the "dry coil" range, is especially valuable for deep coils having overall CF values above 0.85.

The considerable number of variables involved in the calculation of evaporator capacities has necessitated use of several simplifying assumptions, most of which are required due to lack of substantial empirical data or for purposes of simplifying the calculation procedure. These assumptions probably account for most, if not all, of the discrepancies between calculated and experimental results. The total calculated capacities, however, being within 5% of the actual values, are within the range of accuracy required for most design and application work in the field of direct expansion evaporators.

Acknowledgment

Great appreciation is extended to Dr. Tamami Kusuda for his invaluable comments, and to Worthington Corporation for use of its experimental data.

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Outside Air at Minimum Cost

With the aid of a charting system, the air conditioning engineer can readily select, from the many ways to control outside air for interior zones, the method that results in the least tax on heating and cooling facilities. This is Part 1. The concluding part will appear next month.

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SUCCESSFUL OPERATION of an air conditioning system serving interior zones depends largely on how well outside air is utilized. When outside air is set to respond automatically to the space requirements, costly operation of water chillers or other mechanical equipment can be eliminated during the winter and minimized during the summer.

Mixing of outside and return air is easily controlled, providing a satisfactory means of modulating the space cooling. How does one determine the type control to use? The choice is difficult because of the number of different factors that must be evaluated. A charting system that plots conditioned space temperature against supply air temperature will be very helpful in making the correct choice.

(Temperatures and humidities applicable to industrial air conditioning vary widely, depending upon the particular requirements of the space. A year-round space temperature of 75 deg F can probably be considered average. Humidity conditions may restrict the use of outside air, especially when space humidity is controlled. If this is the case, a humidity controller capable of activating the control sequence may be used. Such a controller can serve as a maximum outside-air limit on a rise in the dew-point temperature above that of the space, and play a part in the control only during adverse weather conditions. For this discussion we consider the control of temperature alone.)

There are eight major ways to introduce outside air, that is, the quantity of outside air may be:

(1) Fixed,

(2) Controlled manually,

(3) Made dependent on mixed-air temperature,

(4) Made dependent on outside-air temperature,

(5) Made dependent upon the mixed-air temperature with provision for minimizing outside air in summer,

(6) Made dependent upon outside-air temperature with provision for minimizing outside air in summer,

(7) Controlled from a room thermostat, minimizing outside air in summer and winter, and

(8) Controlled from a room thermostat, minimizing outside air in summer and winter, with provision for safeguarding against apparatus freeze-up.

It will be shown how the same basic charting technique is applied to each method of control.

In Fig. 1 is shown the basic Air Mixture Chart whose ordinate is the supply air mixture temperature and whose abscissa is the outside temperature. The chart also contains lines of constant percentages of outside air. Thus, at any point on the 100%-outside-air line, air mixture temperature equals outside air temperature, and at any point on the 50% line, the air mixture temperature represents the result of mixing equal quantities of air at the corresponding outside air temperature and of 75-deg room air.

Superimposed on the Air Mixture Chart (Fig. 1), line *ABC* is the locus of all points which satisfy the heat balance in an arbitrarily chosen space, which space is a particular single-story plant's interior zone with unexposed walls but exposed ceiling. Point *A* was derived by calculating the supply-air temperature required to offset the net heat loss from the space when it is —10 deg outside, taking into consideration heat dissipated from electrical equipment, lights, human occupants, and the heat loss through the ceiling. Point *B* was similarly calculated for the condition when room and outside temperatures are equal.

Given a fixed supply-air quantity, Q cfm, point *A* tells us that at —10 deg outside, the required supply-air temperature must be 73 deg. Room cooling effect, then, is $(Q)(1.1)(75\text{-}73)$ Btu per hr. Reading point *B*, at 75 deg outside, the required cooling is $(Q)(1.1)(75\text{-}60)$ Btu per hr, which, as might have been anticipated, is a greater quantity.

The two temperature differentials (75-73) and

* Operated for the United States Atomic Energy Commission by the General Electric Company.

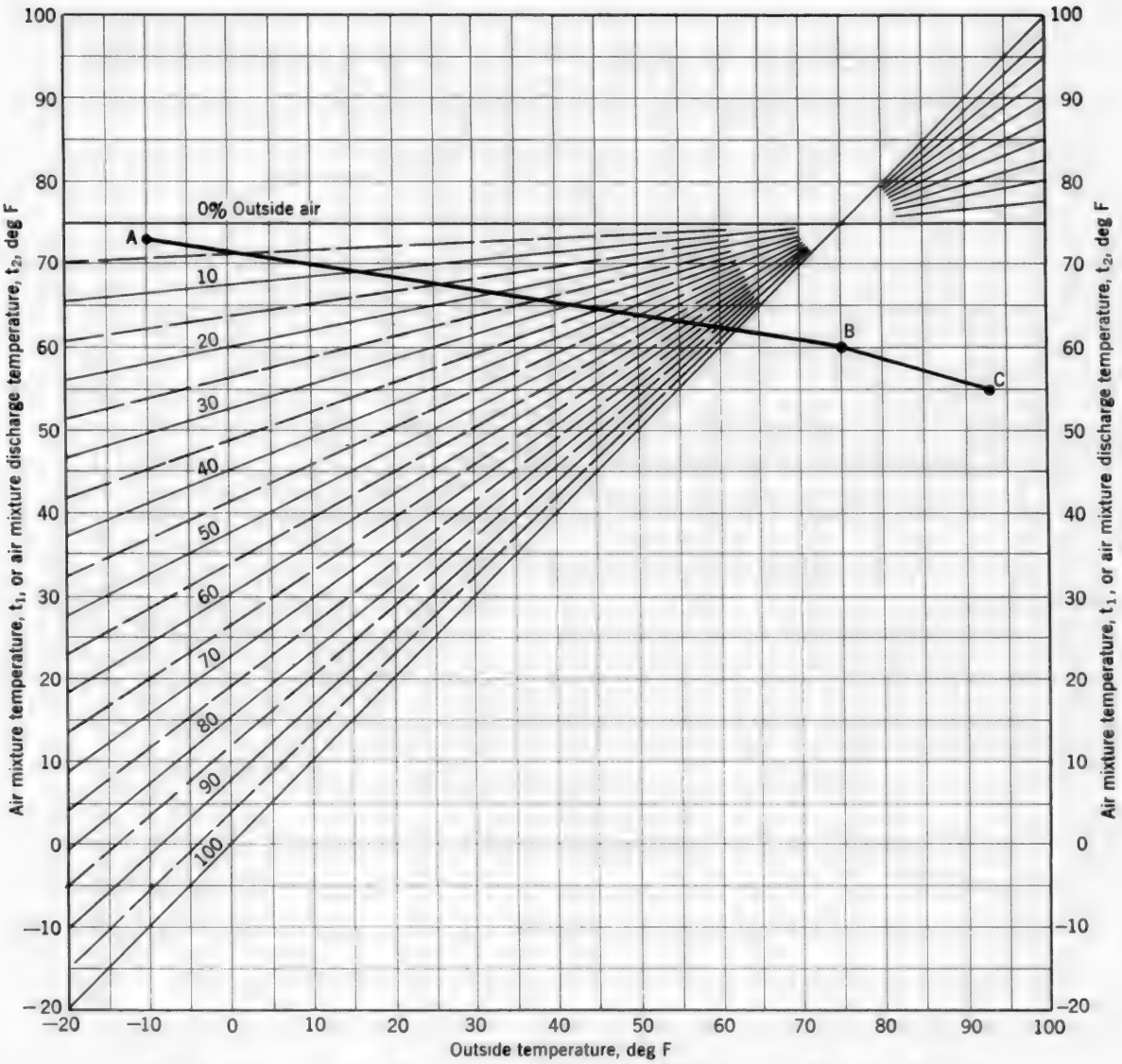

Fig. 1. Air mixture chart is easily drawn. Placement of 0% outside air line is dictated by choice of room temperature, here 75 deg F. Line ABC is characteristic of a particular conditioned space, showing those air mixture temperatures that will offset heat losses or gains.

(75-60) are those differentials that satisfy the heat balance of the space at the two outside temperatures. Each point represents a temperature differential, a temperature differential which, it can be shown, varies linearly with outside temperature. Therefore, the straight line *AB* describes all possible conditions from *A* to *B*.

Line *BC* is similarly established. Point *C*, however, falls below a straight line projection of *AB* because in hot weather solar heat transmission must be considered and added to the conduction heat gains. Line *ABC* describes the year-round supply-air temperatures which will theoretically satisfy the space requirements. Of course, some variation from the theoretical in the temperature of the air actually supplied to the room will occur as a result of changing internal space heat gains from time to time and the corresponding response of temperature controls.

Notwithstanding such control action, it is possible to superimpose the results of any control sequence on the Air Mixture Chart and determine how effectively controls function with respect to the utilization of outside air. Any theoretical divergence from line *ABC* will then represent costly apparatus cooling or heating necessary to effect control due to inadequacy of the controls themselves or because of other limitations. One limitation, for example, is the minimum outside air required for adequate ventilation during the winter. This usually adds to the apparatus heating load and shows up as an excursion from the economically ideal heat balance.

How well do control arrangements utilize outside air? The following evaluations made with the chart just described should clearly demonstrate the un-

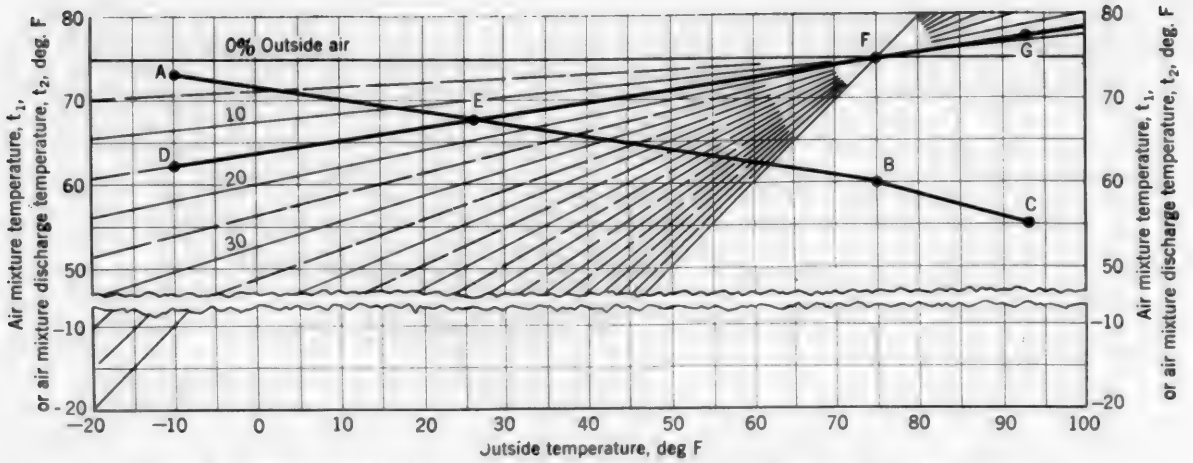

Fig. 2. Superimposed on the air mixture chart, with line ABC, of Fig. 1, is line DEFG, corresponding to a constant 15% outside air. The chart shows that, when outside air is —10 deg, mixed air must be heated from temperature at D to temperature at A to satisfy room conditions.

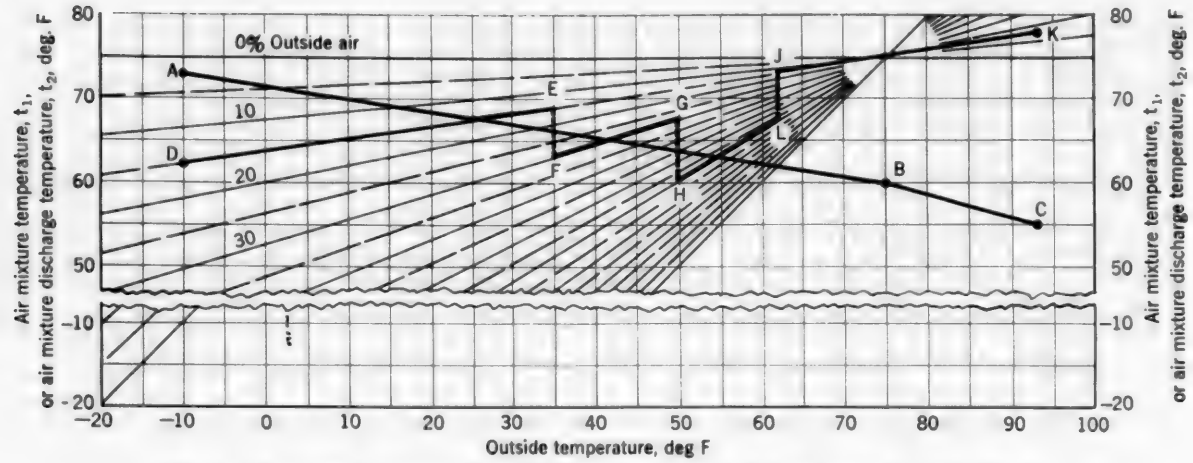

Fig. 3. Air mixture chart and line ABC are the same as in Fig. 1 and 2. As is Fig. 2, 15% is the minimum outside air permissible. Broken and jagged line represents responses to manual adjustments of outside-air damper.

necessary waste of power and fuel commonly associated with inadequate control.

1. Fixed Quantity of Outside Air

In Fig. 2 the situation where a fixed quantity of outside air (15%) entering the air conditioning apparatus is shown on the Air Mixture Chart. Line *ABC* (as in Fig. 1) indicates the theoretical supply-air temperatures which will satisfy the space. Line *DEFG*, superimposed on the 15%-outside-air line, is a plot of actual air mixture temperatures before any apparatus cooling or heating is done. The chart shows it is necessary to heat the air mixture 11 deg when outside temperature is —10 deg, and in lesser amounts as the outside air rises to 26 deg, and that upon a further rise in the outside temperature, increasing amounts of apparatus cooling is needed. Some form of apparatus work is required at all times except at 26 deg outside air temperature.

2. Manually Controlled Outside Air

Figure 3 shows temperatures of manually controlled quantities of outside air required to maintain specific heat levels. The minimum requirement is 15% during winter and summer. Lines *DE*, *FG*, *HL*, and *JK* represent the results of a possible series of adjustments which might be made. Lines *EF*, *GH*, and *JL* denote changes in the adjustment of the manual damper. It will be noted line *ABC* is intersected in three places where the manual setting of the outside damper satisfies the room requirements. Otherwise, apparatus cooling or heating is required.

In next month's concluding installment, the author describes six other methods for controlling outside air and selects those he considers the most economical.

How Much Building Insulation Is Economically Justified?

Engineering literature contains surprisingly little on the economic thickness of building insulation—that is, the determination of that precise thickness warranted by economics. The author of this Reference Section originally became interested in the subject in connection with electric heating, where the relatively high cost of energy calls for more than the usual amount of insulation. He has here extended his original thinking to the point where his formula is universal, in that it applies to all fuels or energy sources, all localities, and all types of buildings, including, in the case of commercial and industrial buildings, allowance for the effect of taxes.

Mr. Thomas graduated from Carnegie Tech in 1937 with a B.S. in Physics. This was followed by graduate studies at Carnegie and at the University of Pittsburgh. He has been associated with Gulf Research and Development Company, U. S. Navy Bureau of Ordinance, was chief engineer of Lacene Manufacturing Corporation, later vice-president of Rev Products Corporation, and is currently in charge of the design of mechanical systems for $7 million of buildings under way by Commonwealth Associates. Married, with three children, his hobbies are playing in a symphony orchestra, home workshop and photography. He is a registered professional engineer in Michigan and Ohio and a member of ASME and ASHRAE.

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March, 1961

AIR CONDITIONING, HEATING AND VENTILATING's

REFERENCE SECTION

TOO OFTEN THE DETERMINATION OF BUILDING HEAT insulation thickness and type has been slighted by designers, with the result that building owners not infrequently pay more than is justified for the insulation at the time of construction or pay heavily for excessive fuel consumption during the life of the building. Inattention to this matter is probably due in part to the considerable number of variables which influence the economically justified insulation thickness, including fuel cost, climate, insulation cost, insulation properties, financial considerations, and so on. Consequently, the designer may, in bewilderment, adopt the indefensible practice of assuming insulation thickness.

What follows is an attempt to show how to assess quantitatively the effect of the more important variables to determine at what thickness of insulation the total of insulation, installed heating equipment, and fuel costs are at a minimum.

This analysis is applicable to any type of building —commercial, industrial, institutional, or residential —in any geographical location. It applies to any form of energy, coal, gas, oil, electricity, or district steam. The approach is to consider the heat transmission through one square foot only of the particular building surface under consideration, and hence is primarily a means for studying building materials, and only indirectly entire buildings. To optimize the insulation for an entire building, a separate study is required for each major surface—wall, ceiling or roof through which transmission heat loss occurs.

Ventilation and infiltration heat requirements are not considered in the study, nor is heat transmission through uninsulated surfaces such as windows and doors.

Usually the basic building construction is dictated by considerations other than heat transmission, so that the designer's problem is frequently limited to

DEFINITION OF TERMS AND SYMBOLS

A = area of building surface considered (one square foot)

a = incremental cost of insulation material per inch of thickness, in dollars per square foot

B = total installed cost of insulation per inch of thickness, in dollars per square foot

b = incremental cost of installing insulation, in dollars per inch of thickness per square foot

C = initial cost, dollars, of insulation and heating equipment per square foot of building surface plus present value of future fuel costs

c = fixed and overhead costs independent of insulation thickness, for installed insulation, in dollars per square foot

D = normal number of degree-days per year for the locality in question

E = average seasonal efficiency of the heating plant expressed as a decimal

F = annual fuel cost for the heat lost through one square foot of the insulated surface, dollars per year

f = average cost of fuel, in dollars per unit quantity

G = installed cost of the heating plant chargeable to one square foot of building surface, dollars

H = design heat loss, Btu per hour for one square foot of building surface

h = heat value of fuel, Btu per unit quantity, where the unit is the same as used in f

i = annual interest rate, expressed as a decimal

J = incremental installed cost of heating system, dollars per square foot of building surface per delivered Btu per hour output

K = a constant in the Strock equation, Btu required per degree-day per 1000 Btu per hour design heat loss

k = thermal conductivity of insulation, Btu-inch per (hr) (sq ft) (deg F temperature difference)

N = life of building or other desired time period, years

P = present worth of future fuel costs, dollars

p = average annual rate of increase in fuel cost expressed as a decimal

Q = average annual heat flow through one square foot of building surface, Btu

R = present worth correction factor for the future uniformly diminishing purchasing power of dollar.

r = annual equivalent income tax rate expressed as a decimal

$s = -2.303 \log_{10} (1+i)$

ΔT = design temperature difference (inside minus outside design temperature), deg F

t = insulation thickness, inches

t_o = optimum thickness of insulation, inches

U = overall heat transmission coefficient of uninsulated surface, Btu per (sq ft) (deg F temperature difference)

U' = overall heat transmission coefficient of insulated surface, Btu per (sq ft) (deg F temperature difference)

W = present worth correction factor for the series of future annual expenditures for fuel

the determination of thickness and type of insulation to be added to a specified basic construction. In other words, the overall heat transmission coefficient of the uninsulated area is usually predetermined.

For the purposes of insulation thickness calculations, the basic construction cost without the insulation does not enter into the problem.

Costs and other constants used in the examples and drawings, although reasonable for the conditions cited, are for purposes of illustration only. Since the equations are designed for universal application, it is important that in each specific case the designer determine accurately the costs which prevail in his locality.

Insulation Cost

The cost of insulation is made up of a, the cost of the insulation itself proportional to the thickness used, b, the cost of installing the insulation proportional to the thickness used and c, the costs of installation independent of thickness, so that the overall cost can be represented by the equation

$$B = (a + b)\, t + c \tag{1}$$

These costs for a typical insulation, in this case ground vegetable fiber blown above a ceiling, are shown graphically in Fig. 1, in which the bottom curve represents the material cost, at, the middle curve the costs of installing, $bt + c$, and the top curve the sum of the lower two, the total cost, or $(a + b)\, t + c$.

Heat Transmission

If U is the heat transmission coefficient for the basic uninsulated construction under consideration, and if an insulation with a thermal conductivity k is to be added, the heat transmission coefficient of the insulated construction, U', can be expressed by the equation

$$U' = \frac{1}{\frac{1}{U} + \frac{t}{k}} = \frac{Uk}{k + Ut} \tag{2}$$

where t is the thickness of the insulation.

Then, if ΔT is the design temperature difference between the air temperature on the inside and that on the outside, and A the area under consideration, the total hourly design heat loss for the insulated construction, H, is

$$H = U'A\Delta T \tag{3}$$

and when A is one square foot

$$H = U'\Delta T \tag{4}$$

Heating System Cost

If the cost of the installed heating system is divided by the number of square feet of building surface, and if the result is G, and if J is the cost of the heating plant per delivered Btu per hour, then

$$G = JH = JU'\Delta T \tag{5}$$

where the value of H from equation (4) has been inserted to obtain the final form of equation (5). Then, combining equation (5) with equation (2)

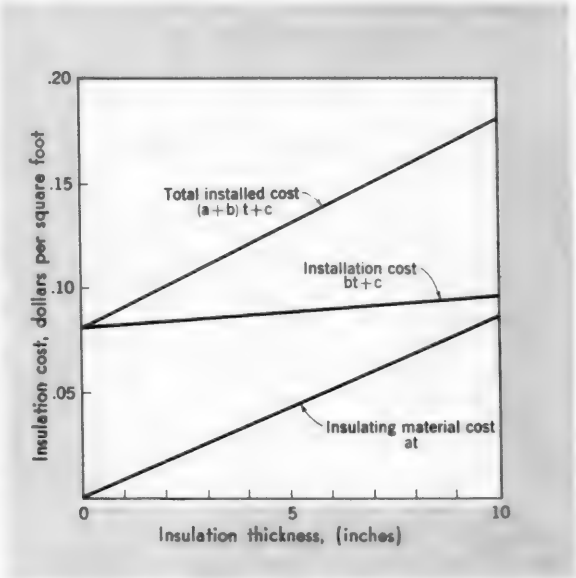


Fig. 1. Typical insulation costs, ground vegetable fiber blown above a ceiling.

$$G = \frac{JUk\Delta T}{k + Ut} \tag{6}$$

Fuel Cost

The annual heat loss through the surface of one square foot can be expressed by the equation*

$$Q = \frac{KDH}{1000} \tag{7}$$

where Q is the annual heat loss in Btu, D the number of degree-days in the locality and K the unit loss per degree per 1000 Btu design heat loss. K varies with the locality as shown in Table 1.

If the unit cost of fuel is designated as f, and if h is the heat content of a unit of fuel f, and the yearly efficiency of the heating system is E, then the annual cost of fuel in present day dollars, F, is:

$$F = \frac{fQ}{hE} = \frac{fKDH}{1000\, hE} \tag{8}$$

However, from equation (4), $H = U'\Delta T$ and from equation (2) $U' = \frac{Uk}{k+Ut}$, so that

$$H = \frac{Uk\Delta T}{k+Ut} \tag{8a}$$

Inserting this value for H in equation (8) we have

$$F = \frac{fkDUK\Delta T}{1000\, hE(k+Ut)} \tag{8b}$$

where F is the annual fuel cost in present day dollars of one square foot of the insulated area.

* Clifford Strock, Air Conditioning, Heating and Ventilating, March 1956, equation (10), page 93.

TABLE I—WEATHER DATA

Degree-Day and K Values for Various Important Cities*

City	K	*Degree Days (D)*
Atlanta, Ga.	538	2,811
Baltimore, Md.	440	4,203
Boston, Mass.	420	5,791
Buffalo, N. Y.	384	6,838
Butte, Mont.	318	9,760
Chicago, Ill.	360	6,310
Cincinnati, Ohio	427	4,532
Cleveland, Ohio	417	5,717
Dallas, Texas	465	2,272
Denver, Colo.	320	5,673
Detroit, Mich.	361	6,404
Duluth, Minn.	295	9,474
Houston, Texas	739	1,276
Indianapolis, Ind.	367	5,134
Kansas City, Mo.	366	4,888
Little Rock, Ark.	485	2,982
Los Angeles, Calif.	1,135	1,451
Louisville, Ky.	430	4,279
Milwaukee, Wis.	338	6,944
Minneapolis, Minn.	311	7,853
New York, N. Y.	424	5,050
Philadelphia, Pa.	429	4,523
Pittsburgh, Pa.	422	5,048
Portland, Oregon	532	4,143
St. Louis, Mo.	424	4,469
Salt Lake City, Utah	369	5,463
San Francisco, Calif.	1,096	3,069
Seattle, Wash.	588	4,438
Tampa, Florida	1,014	674
Tulsa, Okla.	436	3,584
Washington, D. C.	433	4,258

* From *Handbook of Air Conditioning Heating and Ventilating*, C. Strock, The Industrial Press, (1959).

Taxes

In the operation of commercial and industrial buildings, fuel costs are tax deductible since they are a legitimate item of expense and consequently, for such buildings, equation (8b) can be multiplied by the term $(1-r)$, where r is the income tax rate expressed as a decimal. On the other hand, for owner occupied dwellings the fuel cost is not deductible, also in certain governmentally-owned buildings or religious buildings there is no tax, then r becomes 0 and the term becomes 1. Therefore, for:

Owner-occupied dwellings, church or other nonprofit institutionally owned property, and governmentally owned buildings—use equation (8b).

Industrial and commercial buildings, or other buildings not tax free—use the following equation:

$$F = \frac{fkDUK\Delta T(1-r)}{1000\,hE\,(k+Ut)} \qquad (9)$$

Interest and Inflation

In order to take into consideration the effect of interest upon the series of future annual fuel costs and reduce them to a single present cost, the present worth factor, W, is introduced where

$$W = \frac{(1+i)^N - 1}{i\,(1+i)^N} \qquad (10)$$

Values of W are given in Fig. 2. However, Fig. 2 should not be used in the solution of problems unless it is desired not to consider the inflation factor, R, described below. Ordinarily W and R are taken together in the form of the product WR.

In order to consider the inflation of future costs due to the probable reduced purchasing power of the dollar, the term R is introduced to adjust future inflated costs to present costs where

$$R = \frac{1}{W}\int_0^N \frac{(1+Np)\,dN}{(1+i)^N} \qquad (11)$$

Equation (11) can be reduced to

$$WR = \frac{1}{s}\left[\left(1-\frac{p}{s}\right)\left(e^{sN}-1\right)+pNe^{sN}\right] \qquad (12)$$

where $1+i=e^{-s}$. Then $\log_{10}(1+i) = -s\log_{10}e$ and $s = -2.303\log_{10}(1+i)$.

Equation (12) is general. Fig. 3 has been plotted to give values of WR versus N for various values of i for the *special case* of $p = 0.0377$, which is the weighted average annual construction cost increase (inflation) over the period 1913-1957, as reported by *Engineering News-Record*.

Summing up, and adding the correction factors for taxes, inflation and interest to equation (9) we have

$$P = \frac{Uk\Delta TfKD(1-r)WR}{(k+Ut)\,1000\,hE} \qquad (13)$$

where P is the present worth of future annual fuel costs in dollars.

Overall Cost

The overall cost C of insulation, heating plant, and present value of future fuel costs can now be determined by adding equations (1), (6) and (13)

$$C = B + G + P \text{ or}$$

$$C = (a+b)t + c + \frac{JUk\Delta T}{k+Ut} + \frac{Uk\Delta TfKD(1-r)WR}{(k+Ut)\,1000\,hE} \qquad (14)$$

Equation (14) is the basic cost equation which gives the relationship of the various variables.

It has been observed in most practical problems that C has a well defined minimum point, at which the

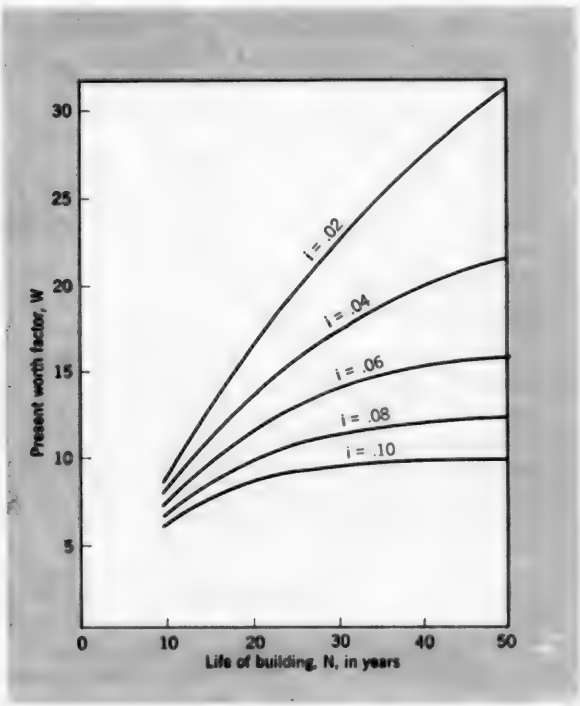


Fig. 2. Present worth factors, W, for various interest rates, i.

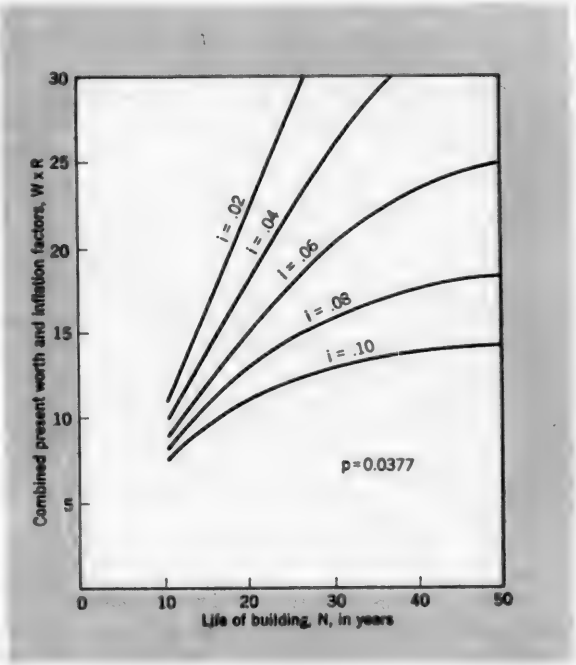


Fig. 3. Combined present worth and inflation factors, WR, for various interest rates.

combined cost of the three terms is a minimum. In order mathematically to find the added insulation thickness for which C is minimum, differentiate equation (14) with respect to t, equate the derivative to zero and solve for t. The final t becomes t_o, which can be called the optimum insulation thickness.

$$t_o = \left(\left[\frac{k\Delta T}{(a+b)}\right]\left[\frac{(1-r)\,(fKDWR)}{1000\,hE} + J\right]\right)^{1/2} - \frac{k}{U} \qquad (15)$$

Equation (15) is the working formula for determining the economic thickness of building insulation.

Example

To illustrate the application of Equation (15) calculate the optimum thickness of a rigid vegetable fiber insulating board on a steel roof deck on an industrial building for the following conditions:

Insulation material—vegetable fiber board	k = 0.36
Design temperatures: inside 66 deg, outside —4 deg F.	ΔT = 70 F
Incremental insulation material cost	a = \$0.120 per board ft
Incremental insulation labor cost	b = \$0.025 per board ft
Nonincremental insulation cost	c = \$0.08 per sq ft
Equivalent income tax rate	r = 0.57
Fuel, No. 6 oil	f = \$0.10 per gal
Building location, Detroit, Mich.	K = 361
	D = 6400
Interest rate	i = 0.06
Expected life of building	N = 25 years
Average annual rate of inflation	p = 0.0377 per year
Combined present worth and inflation factors (taken from Fig. 3)	WR = 17.8
Heat value of No. 6 fuel oil	h = 152,000 Btu per gal
Seasonal efficiency of heating system	E = 0.70
Incremental cost of heating system	J = \$0.006 per Btuh
Heat transmission coefficient of roof, less insulation	U = 0.90

Inserting the above values in Equation (15) we have

$$t_o = \left(\left[\frac{(.036)(70)}{(.120 + .025)}\right]\left[\frac{(1 - .57)(.10)(361)(6400)(17.8)}{(1000)(152{,}000)(0.70)}\right] + .006\right)^{1/2} - \frac{0.36}{0.90}$$

t_o = 1.58 inch. Use 1½ inch.

Typical Cost Curves

Figs. 4 to 6 are shown to illustrate graphically the significance of Equation (15). Ordinarily, however, it is not necessary to plot curves to determine optimum thickness, since Equation (15) may be more readily used for the purpose.

Fig. 4 shows costs in dollars per square foot for the same insulated roof deck considered in the example given previously and using the same assumptions as in that example.

Note that there are four different curves in Fig. 4. Curve B shows the variation of installed cost of the insulation with added insulation thickness. It includes both labor and material, also incremental and nonincremental costs. Note that term c which was not needed in the optimum thickness calculation was needed in plotting Curve B.

Curve F shows the variation of the present worth of future fuel costs for heat passing through the surface with added insulation thickness. Curve G shows the variation of heating system installed costs with added insulation thickness.

Curve C is the sum of the other three curves (B, F and G) and represents the total cost. Note the dip or minimum point in Curve C. The insulation thickness corresponding to this minimum cost is the optimum insulation thickness. The value is shown to be 1.58 in. which is the same as determined by the use of the optimum thickness equation.

Fig. 5 gives similar curves for a different material with different assumptions, *i.e.*, an insulated metal curtain wall for an office building. Following are the assumptions.

Insulating material — Flexible glass fiber blanket	k = 0.37*
Design temperatures, inside 72 deg, outside 5 deg.	ΔT = 67 deg
Incremental insulation labor and material cost	$a + b$ = \$0.40
Nonincremental insulation cost	c = \$1.25
Equivalent income tax rate	r = 0.50
Fuel, district steam	f = \$1.35 per 1000 lb
Building location New York City, New York	K = 425 D = 5050
Interest rate	i = 0.06
Expected life of building	N = 50 years
Average annual rate of inflation	p = 0.0377 per year
Combined present worth and inflation factors (from Fig. 3)	WR = 25.3
Heat value of 1 lb of steam at 100 psig	h = 889 Btu per lb
Seasonal efficiency of utilization of fuel	E = 1.00
Incremental cost of heating system	J = \$0.017 per Btuh
Heat transmission coefficient of wall, less insulation	U = 0.55

Note again the three individual cost curves which when added give the total cost. The optimum thickness is shown to be 1.41 inches. A 1½ inch insulation would be used.

Fig. 6 gives cost curves for still another insulating material with different assumptions. The insulation is blown mineral wool above a plastered ceiling. The assumptions are as follows:

Insulation material, blown mineral wool	k = 0.30
Design temperatures, inside 72 deg, outside —5 deg	ΔT = 77 deg

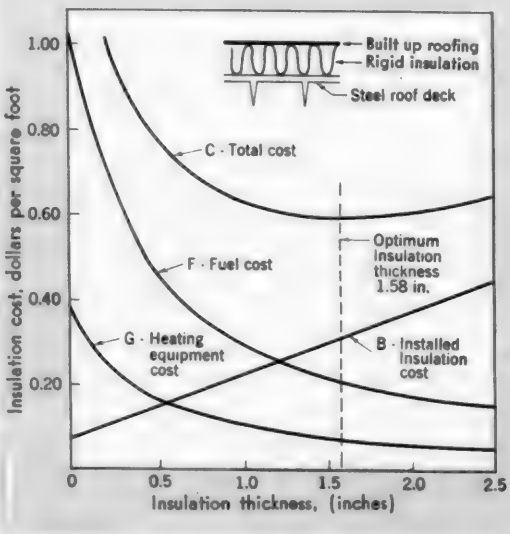


Fig. 4. Cost versus insulation thickness curves (typical) for a rigid vegetable fiber roof insulation. Fuel, No. 6 oil.

* The value for the insulation alone is 0.27 but because of the various metal connections passing through the insulation from the cold to the warm side the equivalent k is increased to 0.37.

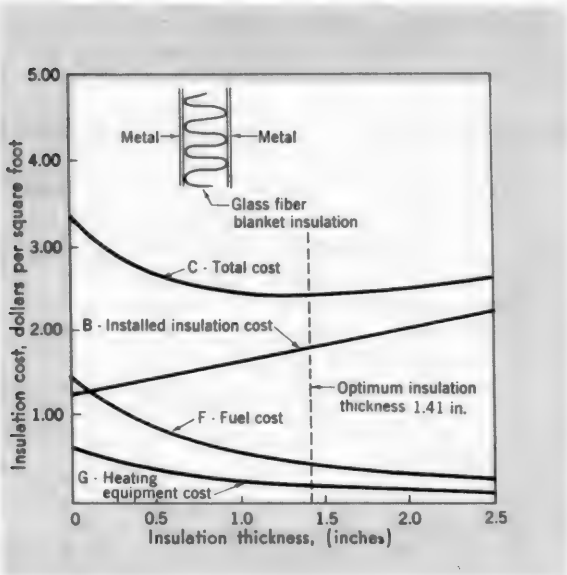
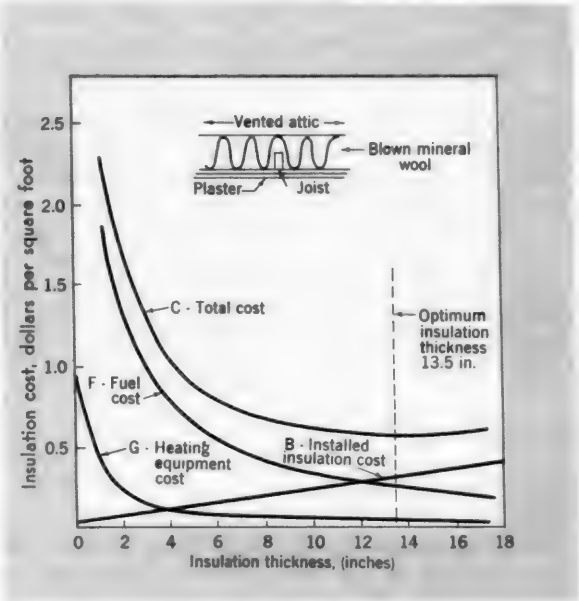


Fig. 5. Cost versus insulation thickness curves (typical) for a metal curtain wall with flexible glass fiber blanket insulation. Fuel, district steam.

Fig. 6. Cost versus insulation thickness curves (typical) for blown mineral wool above a plastered ceiling. Fuel, electricity.



Incremental insulation material cost	a	= \$0.012
Incremental insulation labor cost	b	= \$0.008
Nonincremental insulation cost	c	= \$0.040
Equivalent income tax rate	r	= 0.25
Fuel, electricity	f	= \$0.015 per kwh
Building location, St. Louis, Mo.	K	= 424
	D	= 4470
Interest rate	i	= 0.06
Expected life of building	N	= 40 years
Average annual rate of inflation	p	= 0.0377
Combined present worth and inflation factors	WR	= 23.7
Heat value of electricity	h	= 3515 Btu per kwh
Seasonal efficiency of utilization of fuel	E	= 1.00
Incremental cost of heating system	J	= \$0.022 per Btuh
Heat transmission coefficient of ceiling less insulation	U	= 0.61

The optimum thickness of the insulation is seen to be 13.5 inches, a surprisingly high figure.

Selecting Insulating Materials

While Equation (15) gives optimum thickness for insulations, it is not intended for use in comparing total costs of various insulating materials. When careful economic comparisons of insulating materials are required, the first step is to select acceptable insulating materials and application methods for the various surfaces in the building, together with alternates. An optimum thickness calculation is made for each. To reduce the amount of work required in these repetitive computations it is suggested that all terms in the equation which do no vary with insulation type be combined and reduced insofar as possible. Although each material under comparison is at this point of optimum thickness, their total installed costs and performances may vary widely, depending upon the costs and properties of the insulating materials.

Note that the term c in Fig. 1, Equation (1) and Equation (14) does not appear in Equation (15). This is because nonincremental costs of the insulation, which do not vary with thickness, were eliminated in the differentiation. Only those costs which vary with thickness are in Equation (15). The nonincremental costs nevertheless are real and must be paid. They are often considerable compared to the incremental costs. They include basic fixed costs which for the large part are not affected by additional thickness such as:

Business overhead;
Ordering, transporting, handling, placing and securing the insulation;
Preparing surfaces; and
Providing vapor barriers.

In addition, there may be incidental building costs for the accommodation of the insulation which in certain cases should be considered in the total cost. Examples of incidental building costs which may be chargeable to the insulation are decreased building

volume, wider foundations, thicker walls, special supports for the insulation, and so on. Unless a very thick insulation is involved, this item may be neglected. If it cannot be neglected, a suitable additive term can be included to consider it in Equation (14).

In order to compare overall costs of insulations, taking into consideration optimum thickness, material costs and properties, nonincremental costs and incidental building costs, a further separate calculation is made for each material considered using Equation (14). The nearest commercially available thickness to the calculated optimum thickness is then used in the total cost calculations for each material. The optimum thicknesses of the various insulations compared may be quite dissimilar. Likewise the combined overall heat transmission coefficient, U', of the various materials, with their respective optimum insulations may vary widely. It is therefore not correct for a designer to establish insulation thickness by simply working toward a preconceived U' value.

Discussion of Terms in the Equations

The terms in the equations are expressed in commonly used units to facilitate solutions.

Fig. 1 illustrates the meanings of a, b and c. To be reliable, these terms should be derived from actual cost data applicable to the exact conditions of the problem considered. Note that incremental costs for additional insulation thickness are often relatively low.

Insulation thicknesses t and t_o used in this analysis are actual, not nominal thicknesses.

An approximation is made in applying the Strock equation at indoor temperatures other than 70 deg. The discrepancy, however, is minor.

For fuels such as gas and electricity where f may vary with consumption, a careful study may be required to determine the true average rate.

The interest considered in this analysis is the rate of return on present dollars which will build the fuel fund up to just meet the future fuel costs as they occur.

In the event that there are substantial heat gains in the building from various sources (such as lighting) other than the heating system, their effect should be recognized by an appropriate reduction of $\triangle T$ in the optimum thickness calculation.

The assumed value of $p = 0.0377$ in Fig. 3 is admittedly a guess. The author claims no ability to predict the future. Fig. 3 is meaningful only if the economic trends of the past half century continue. It certainly seems reasonable, however, to make some allowance for this well established trend.

Note that the factor W tends to make present dollars become more valuable in the future, while R makes them become less valuable, hence they tend to some extent to offset each other.

Note also that in the definition of G and J it is assumed that the heating plant is sized exactly to the design heat loss, H.

The Optimum Thickness Equation

Equation (15) combines in a single relationship the more important factors affecting insulation thickness. It was not feasible to include the following:

Summer cooling equipment savings;
Summer cooling operating savings;
Depreciation, repair or replacement of heating and cooling equipment;
Nonfuel heating system operating costs; and
Insurance

nor was it possible to take into consideration the benefits of insulation to building occupants in added winter and summer comfort, and in sound and noise reduction.

Equation (15) provides a means for studying the effect of individually varying any of the terms. It will likely yield higher insulation thicknesses than presently in general use. In order to derive the greatest benefit from insulation one of the most important considerations, perhaps not generally appreciated, is low installed insulation cost. Another highly important factor affecting insulation selection is the relatively long life of the building during which the fuel savings are made.

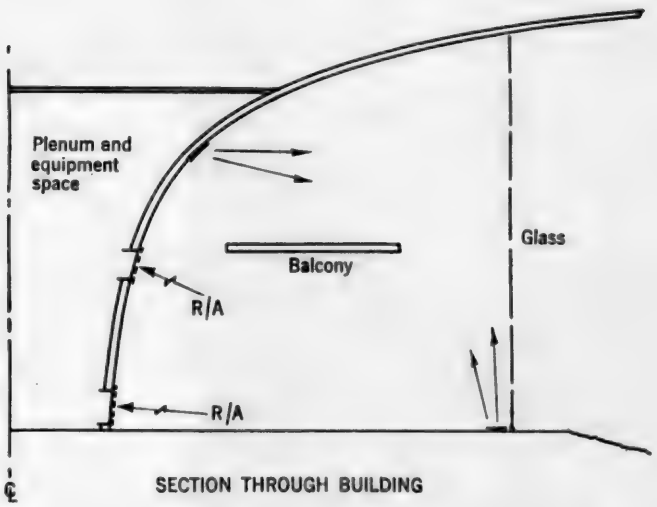
Application of Equation (15) should be tempered with judgment and a sound knowledge of building materials, design, construction and financing.

Some practical considerations which may override the calculated optimum thickness are:

1. The building design and construction may not accommodate the thick insulation.
2. Abrupt discontinuities in building costs may occur when increasing the insulation space necessitates more expensive building construction.
3. Codes may dictate construction details which may limit insulation space.
4. The optimum thickness may not be commercially available.
5. Prevention of moisture condensation may govern insulation thickness.
6. The building owner may desire that the basic economics upon which the equation was based be varied. For example:
   (a) He may want to minimize present investment in insulation and heating equipment without regard for future fuel costs.
   (b) He may want to amortize the cost of the insulation over a specified period which is less than the life of the building.
7. High thermal conductivity building materials, such as structural steel, through bolts, fastenings, and so on, particularly if metal, which penetrate the insulation from the cold to the warm side, if large or numerous enough can to a considerable extent offset the value of the nearby insulation.

Condensation on display windows has been a headache to store managers for years. In the North, it occurs in winter — on the inside. In the South, it happens in summer—on the outside.

Prevention of Condensation On the Outside of Display Windows



SECTION THROUGH BUILDING

LOUIS H. V. SMITH
Consulting Engineer, Sarasota, Florida

WITH THE ADVENT of the air conditioned roadside showcase, the ability of the building to draw viewers (potential buyers) even after closing becomes an important part of the sales effort. Galloways, in Sarasota, Fla., selling a line of better furniture and landscaped to create a park-like atmosphere, performs just such a function. The building is an 88-ft diameter showcase with 18-ft high glass on all sides. A circular area at the center contains equipment and wash rooms. See sketch.

Air conditioning, as originally installed, consisted of a perimeter system with ducts below the floor. This performed well with but two exceptions: One, balcony cooling was inadequate; and two, there was no control over glass temperature. Condensation invariably occurred with a high outside dew point, since glass temperature was lowered by being washed with supply air. Balcony cooling was accomplished by throwing air onto the balcony through specially designed wood louvre grilles in the wall of the center section as shown on the sketch. Air could not be diverted from the peripheral registers for these grilles since the total air being circulated was already low for the volume of building being served. To correct this condition and to provide air circulation for the balcony, additional fan capacity was installed equal to that already existing.

The net result of the addition of such fans and grilles is to provide two systems of air distribution (balcony and perimeter) controlled by a set of motor-operated dampers. Thus, cold air off the coil can be mixed with return air and supplied to both systems. Alternately, cold air can be supplied to the balcony with warmer (return air) supplied to the perimeter system as necessary.

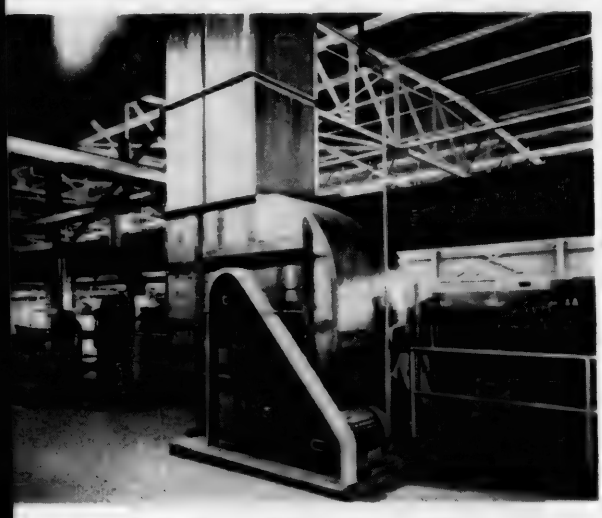
Window fogging is prevented by supplying warmer air to the perimeter grilles whenever the outside dew point is low enough to cause condensation on the glass.

It has been my observation that this condition exists only during a rain or during evening sales hours on a warm moist day when the outside dry bulb is dropping rapidly—as it invariably does in subtropical climates. At such times, envelope load on the building is sharply reduced. The sun is either behind a cloud or set, and consequently the outside dry bulb temperature is reduced along with the sun load. This reduced envelope load permits cooling of the building by the balcony grilles alone. Spill-over from the balcony mixes with warmer air from the perimeter system, so that return air under the balcony suffices to cool the ground floor sales area.

The control sequence calls for cooling air from both balcony and perimeter grilles when outside ambient and sun load are high and there is no danger of condensation on windows. Evenings, when conditions conducive to condensation exist, a time clock (or dew point control stat) diverts return air to the perimeter grilles. If outside dew point continues to rise, the dew point control stat calls for heat to be added to the perimeter air stream by a gas-fired unit heater. The addition of load must, of necessity, be added to the equipment load during this period so the unit heater is cut in only for extreme conditions.

Air System for Paper Mill Performs Nine Jobs

◀1



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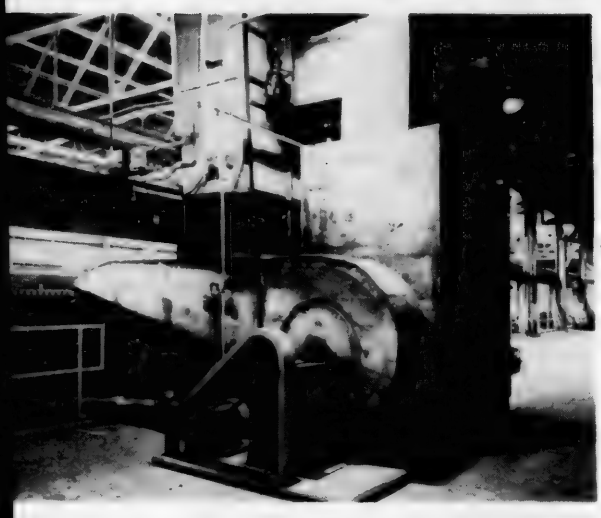

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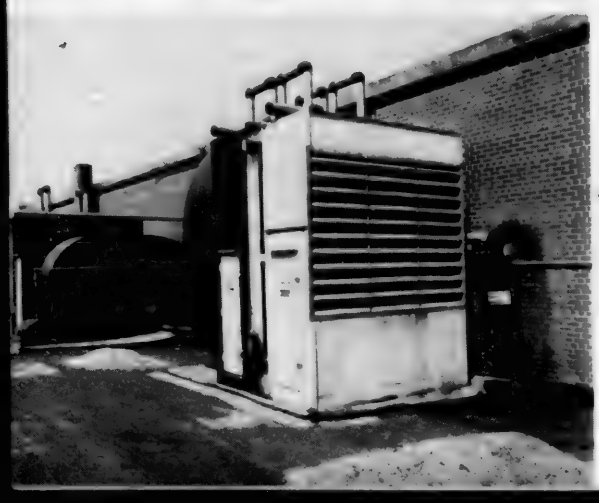


◀4

THE AIR SYSTEM FOR UNION BAG-CAMP'S NEW NO. 7 machine in Savannah, Georgia performs nine different functions, all essential to high speed, economic paper production, and to satisfactory machine-room temperature and humidity.

Overall system, supplied by J. O. Ross Engineering Div., Midland-Ross Corp., New York, N. Y., comprises a number of independent units, some of which are shown.

Most impressive of the air system units is the hood which totally encloses the dryer portion of the machine, as shown in Fig. 1. The hood, in three sections, allows space for a breaker stack and size press between first and second and second and third sections, respectively.

Hood is constructed of aluminum panels, each comprising a pair of aluminum sheets encasing an insulation liner. Roof panels, heavily insulated to prevent condensation, have 3 inch thick mineral wool liners. Side panels have insulation-board cores which add to their rigidity. Panels along the drive side of the machine are mounted on tracks at the eave of the hood and slide back and forth to allow access to the machine.

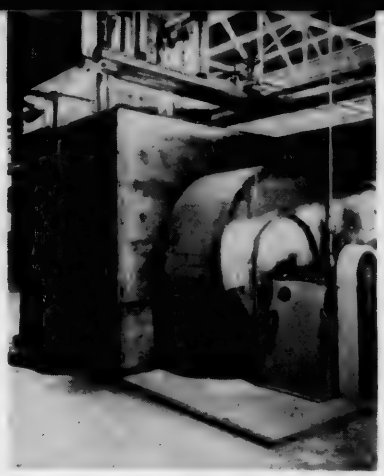
Panels along the operator's side are of two types. Fixed panels extend downward from the eave of the hood to within approximately 8 ft of the floor. Lifting panels, extending from the fixed panels to the floor, are raised by means of attached cables that wind around roof-mounted drums when the lifting motors are operated.

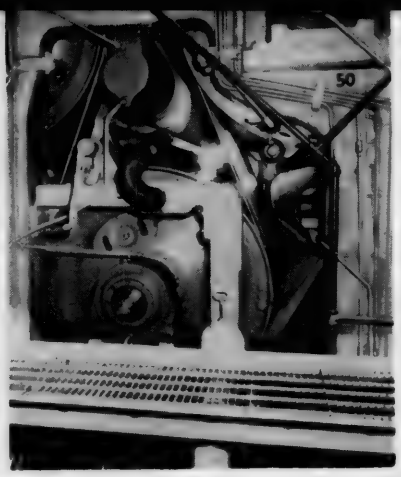
Air is exhausted from beneath the hood by five fans, one of which is shown in Fig. 2. Fan intakes are connected to plenum chambers which run along the inside of the hood sections, at the top and along the drive side. Fans exhaust to atmosphere via Transite ducts extending through the roof.

Number 7 machine is equipped with three felt drying units which supply heated air to dry the bottom felts. Supply equipment for one of the felt dryers is shown in Fig. 3. The insulated fan in the foreground discharges heated air through the horizontal duct to the downward vertical one which distributes it to high velocity vapor absorption nozzles across the width of the felt.

The heater box, which raises the air temperature from as low as 20 to 140 deg F, is shown behind fan, Fig. 3. Air to heater box is supplied both from the outside, and from the hood exhaust. Ratio of exhaust air to outside air is automatically regulated by dew-point controls in the hood exhaust duct. When the machine is running at less than rated speed, and the moisture content of the exhaust air is relatively low, the dew-point control operates a damper which permits more exhaust air to recirculate. Air is heated by stainless steel steam coils.

The machine room has two roof heating and ventilating





5 6 7

units, one for each end of the room to prevent moisture from condensing on the ceiling and supporting structural members. The right hand unit in Fig. 4 is one of the heater and fan units. Air enters through the louvered section, passes over stainless steel steam coils and into the fan inlet for distribution into the machine room.

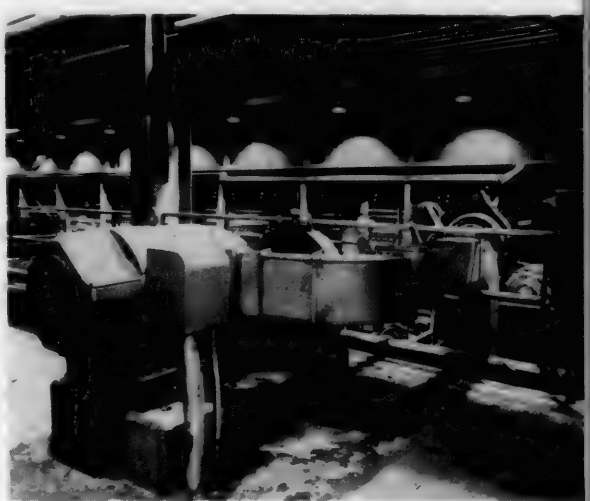
Two wet-end exhaust units (not shown) comprise enclosed fans located on the roof above the wet end of the machine. These fans draw vapors up through roof outlet, minimizing spillage into machine room.

8 ►

The two Dryjector units provide ventilation for the vapor pockets formed by the sheet, dryer and felt rolls. A complete unit consists of circulating fan, air heater, distribution ductwork and connections to machine doctorbacks. Fig. 5 shows air inlet duct from the roof, heater box, and centrifugal fan which distributes the air to headers along both sides of the machine. Fig. 6 shows a riser from the header at the front side of the machine. This riser connects with a segment of the machine frame which was supplied hollow by the machine builder to conduct the airflow. Provisions were also made for the damper connection shown in constructing the machine. A flexible hose connects the hollow frame to the doctorback which carries the air to an outlet.

Air exhausted from the room by hood exhaust fans and wet-end exhaust units exceeds that supplied by the felt dryer system, roof heating and ventilating units, Dryjector and other units. Therefore, additional air is supplied by two air make-up units, one for each end of the room. Fig. 4, left, shows the fan and heater box for one make-up unit. Insulated ductwork with side outlets distribute the air to the machine room. In the summer this air is used for comfort cooling.

9 ►



Five electrical control rooms are cooled and ventilated to maintain optimum conditions for operation of electrical equipment. Fig. 7 shows two packaged 10-ton cooling units mounted outside a room housing electrical controls and an M.G. set, as shown in Fig. 8. A return outlet to one of the outside cooling units can be seen near the bottom of the right hand wall. The room is maintained under slight positive pressure by the introduction of charcoal filtered fresh air. This presents possible infiltration of corrosive elements which attack equipment.

10 ►

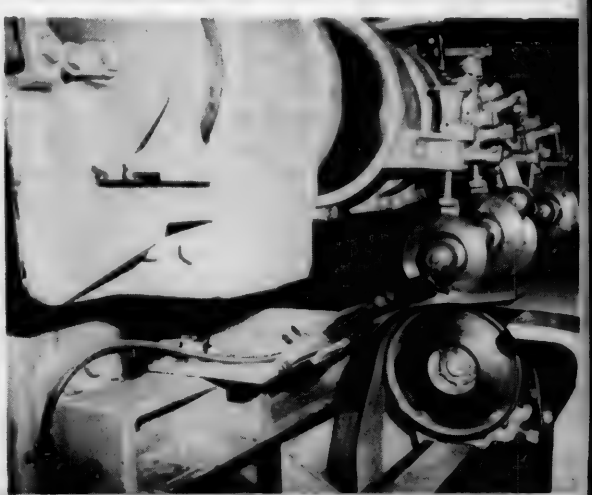


Figure 9 shows a duct from a fan which cools a mezzanine mounted motor. Trim conveyor, Fig. 10, directs edge trim into a duct which pneumatically conveys it back for reprocessing.

Automatic, Remote Tunnel Ventilation System Includes Protection Against Equipment Breakdown

Fifty miles from Denver sprawls the 6 mile length of the world's second largest railroad tunnel. Situated on Denver & Rio Grande Western Railroad's main line through the Rocky Mountains, Moffat Tunnel posed a unique problem to crews responsible for maintenance of the extensive automatic ventilation system.

The system, installed to provide for exhausting of fumes and cooling of transit locomotives, consists of two large fans with a heavy drop curtain at the tunnel's East portal. One fan, a high pressure, relatively low air volume unit, ventilates the tunnel and applies pressure against Eastbound locomotives while they are in the tunnel, cooling them during their climb. This fan is a Clarage squirrel-cage unit with 9-ft dia curved blades. With a 750-hp Allis-Chalmers wound-rotor motor turning at 353 rpm, it delivers 260,000 cubic feet per minute when the tunnel is empty.

The second fan, an American Blower circular unit with 10-ft dia flat blades, is a high pressure, low volume fan. Delivering 300,000 cubic feet per minute at 392 rpm, it is driven by a 500-hp Allis-Chalmers wound-rotor motor.

The Clarage fan provides general ventilation and also provides a cooling air stream for locomotive engines. It starts operation just prior to the entry of the head of the train into the tunnel, and continues to operate as long as the train is in the tunnel. The American Blower unit is responsible for fume exhausting. It commences operation once the train is in the tunnel, and continues to work for a short while after the train has left the tunnel.

The drop curtain at the East end of the tunnel is used primarily to "plug" the East portal while smoke and fumes are evacuated out the West end of the tunnel. Fans, located at East end, provide positive air pressure within the tunnel; pressure differential varies from 2.5 to 6 inches water—sufficient to effect one complete air change throughout the entire 6.2-mile tunnel span in 30 minutes. Air velocity averages 1144 fpm. A secondary use of the curtain is to prevent unauthorized entry into the tunnel; hence it is left down at all times except during train passage through the East portal.

Both ventilation equipment and drop curtain are actuated by track circuits, which, in turn, are activated by train passage over certain sections of track. This is the same system that is used to control railway semaphore signals.

In such an automatic remote installation, supervision consists of relatively infrequent maintenance visits. Because of the presence of automatic protection devices, no regular check is made on the fan or motor bearings, fan blade roots, or any of the other parts of the system under working strain.

Unless detected, imminent mechanical malfunction may progressively worsen over an extended period of time. Hence, the possibility of severe damage occurring is constantly present, with the resultant probability of extended down-time.

To reduce the probability of severe damage occurring, D&RGW engineers decided upon a vibratory malfunction detector which would react to early signs of bearing failure, fan root weakening, lubrication starving or the like, and instantly warn supervisory personnel of the condition. Vibraswitch malfunction detectors, manufactured by the Aeronautical and Instrument Division of Robertshaw-Fulton Controls Co., were selected.

The Vibraswitch malfunction detector is said to be unique in its method of detection of incipient failure. Rather than being sensitive only to actual displacement vibration, the device is sensitive also to acceleration vibration and vibrational velocity. In addition, because of the nature of the pivot of the moving beam within the detector, it is more sensitive to higher vibrational frequencies. This is important, because initial bearing failure symptoms are contained in the low intensity, high frequency vibrations which are set up by the flaw. This also applies to the first symptoms of lubrication-starved bearings and blade root fractures.

Vibraswitch construction is essentially that of a vibrating reed relay. As shown in diagram, it consists of a pivoted beam with a sensitive switch bearing against it. The pivot consists of a leaf spring held in shear between the beam and the base of the detec-

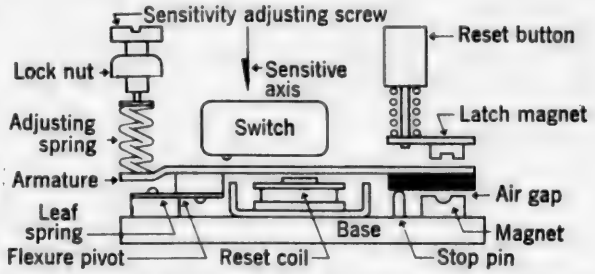
tor; this type of pivot is best known as a flexure-pivot and yields extremely low friction co-efficients.

The beam, or armature, is held by a coil spring at one end, with the other end resting upon a stop pin inside a magnetic field created by two permanent magnets. Acted upon by vibration, the inertia of the armature tends to hold it against the stop pin, aided by the attraction of the magnet beneath the beam and the force applied by the coil spring. However, once the vibration becomes great enough to move the armature from the stop pin, the inertia of the armature will keep it in motion until it contacts the other magnet. In the course of moving from the stop pin and into contact with the upper magnet, the sensitive switch is operated by the beam.

The amount of vibration needed to start the armature moving is determined by the spring on the end of the armature farthest from the magnets. This spring is fully adjustable. Once the armature touches the upper magnet, it "latches" there until it is mechanically moved back to the stop pin. This may be accomplished in either of two ways.

A reset button is provided to enable manual resetting of the device by pushing it away from the latching magnet and back to the stop pin. Alternatively, a magnet coil mounted on the base of the detector may be activated from any remote point. The magnetic field this creates will attract the armature away from the latching magnet and will move it back to the stop pin. This latter method also prevents false actuation during start-up cycles.

D&RGW engineers have installed vibration detectors in three locations on each fan/motor assembly—at the outboard bearings, at the inboard bearings and at the flexible couplings. The Vibraswitches are electrically connected to a maintenance switchboard in Denver. When a detector trips, the affected equipment is automatically shut down and the indicator in Denver alerts maintenance personnel to the situation.



This diagram shows the construction of the Vibraswitch malfunction detector; the various components are described in the text. Photo on opposite page shows train leaving the Western portal of the Moffat Tunnel.

In the relatively short time the protectors have been in service, they have proven their worth a number of times. In one particular instance, off-normal vibration was detected and, when service personnel arrived, was found to be the result of excessive play between fan and motor shafts. In the opinion of railroad officials, had this fault gone undetected a serious, expensive and inconvenient breakdown would have occurred.

In such an installation, where equipment is operated for short periods and is automatically started and stopped, breakdowns can cause discomfort to passengers and possible damage to other equipment. For this reason, early detection of impending failures, by preventing the actual occurrence of the breakdown, is economically important to the railway.

Two-Part Approach to Apartment Conditioning

Syracuse's Imperial Gardens, the first fully air conditioned major apartment building in Central New York, will use a two-part system to prevent seepage of air from living spaces along corridors.

According to the installing contractor, one half of the system will supply conditioned outside air to apartments and hallways from central apparatus in the basement. Air sent into the apartments will equal that removed through fan-driven exhausts located in kitchens and lavatories.

In the other half of the system, 375 Carrier fan-coil units located under windows will maintain comfortable temperature and humidity levels in the 115 apartments. Each unit can be individually controlled by the tenant.

Two hot water boilers and a Carrier water chilling machine with 250 tons cooling capacity will also be located in the basement.

Prior to selecting the new central system for Imperial Gardens, Syracuse architect Edward C. Roock compared the two-part approach with through-the-wall room coolers. The trend in apartment air conditioning has only recently advanced from conditioners in windows to larger-capacity, through-the-wall units. Mr. Roock's study showed the central system, which is ahead of the trend, would cost slightly more initially, but will be less expensive to own and operate over its 20-year life expectancy.

General contractor is W. C. Pahl Construction Co.; installing contractor is Cooney Air Conditioning, Inc.

New aid for specifying

Protective Coatings for Fans

An explanation of Air Moving and Conditioning Association's new Recommended Practice for preparation of fans and of fan parts for protective coatings, appearing on the Data Sheet, next page.

C. J. TRICKLER

Chairman, Project P117NB, Air Moving and Conditioning Association, Detroit, Michigan, and Chief Engineer, The New York Blower Company, La Porte, Indiana

MANY FANS AND BLOWERS HANDLE CORROSIVE FUMES or are exposed to corrosive atmospheres. A great variety of coatings are available to prevent corrosion, requiring various degrees of metal preparation prior to application. Air Moving and Conditioning Association has prepared a *Recommended Practice* to serve as a guide for those who specify the preparation of fans and blowers for the application of coatings. Its use by fan users, coating manufacturers and applicators, and by fan and blower manufacturers will avoid the confusion that often prevails when competitive fan quotations are based on different degrees of preparation. Better quality coatings will also result since the *Recommended Practice* makes it easy to accurately specify the degree of preparation that is needed for each particular coating.

Protective coatings run the gamut from relatively inexpensive "acid resistant" and bitumastic paints that are meant for mild corrosion or moisture resistance, to coatings of vulcanized rubber or similar materials that are designed for handling extremely corrosive chemical fumes. In between are hundreds of commercially available general and special-purpose coatings.

Quality of the finished coating is greatly dependent upon the quality or degree of preparation of the fan or blower before coating. For example, it is difficult to get good coverage of any paint or coating over sharp metal edges produced in a normal shearing operation. While it might be economically unreasonable to spend a lot of time removing these sharp edges in preparation for coating with inexpensive bitumastic paint to withstand normal atmospheric corrosion, it is just as economically unreasonable to omit any step that would increase the durability of the quite expensive heavy vulcanized rubber coating.

The AMCA *Recommended Practice* is not an attempt to advise what degree of preparation is necessary for a particular coating, nor is it an attempt to advise what coating is suitable for a particular corrosion problem. These are the proper functions of coating manufacturers and applicators. This *Recommended Practice* does present a standardized scale of preparation steps or procedures. By its use, the specification writer, fan manufacturer, coating manufacturer and applicator can have a common intelligent understanding of what is to be done in preparing fans for coating.

Preparation of fans for protective coatings takes two forms. One is the treatment applied to the metal surface to remove grease or scale that would prevent the coating from adhering and to assure that the surface has good "tooth" for adhesion. The other considers the changes in construction of the fan or blower most suitable for the coating involved. For example, it may be necessary to use continuous welding where normal fabrication utilizes intermittent welding, or it may be necessary to change the design of a part so that a threaded fastener normally in the airstream is placed out of the airstream.

Generally speaking, the farther one goes down the scale of preparation steps the more expensive the preparation becomes and the better will be the quality of the finished coating.

Air Moving and Conditioning Association is indebted to the National Association of Corrosion Engineers for their cooperation in writing the *Recommended Practice*, and particularly so to Mr. Arno J Liebman of that organization.

PROTECTIVE COATINGS FOR FANS AND FAN PARTS

Recommended Practice adopted by Air Moving and Conditioning Association, Inc., 2159 Guardian Building, Detroit 26, Michigan

I. *Scope*

This recommended practice provides a guide for preparation of fans and fan parts for protective coatings. Recent years have seen a steady increase in the air moving applications requiring protective coatings on fan parts. The variety of coatings available and the techniques prescribed by the coating manufacturers for the preparation of the object to be coated, has caused Air Moving and Conditioning Association (AMCA) to develop this recommended practice. It makes no attempt to recommend coatings or the degree of preparation necessary for each coating. The standards listed here are presented as an aid to the specifier.

II. *Applicable Documents*

A. There are no applicable documents for this specification.

III. *Effect of Abrasion, Erosion, Corrosion and Excessive Heat*

A. To study the effect of abrasion, erosion, corrosion or excessive heat, investigation and experimentation have been made with plate alloys, materials, coatings and forms of construction. To date, no materials or means have been discovered which will effectively and completely resist all such effects. Some materials are better than others. The resistance to such effects, therefore, is one of degree only.

B. Experience having shown, on the basis of present-day knowledge, that abrasion, erosion, corrosion or deterioration from excessive heat are speculative assumptions of maintenance, it is the policy of the Association to advise buyers of fan equipment that guarantees covering such conditions cannot be made in good faith.

C. Bearings cannot be adequately protected. On severe corrosion applications it is recommended only single inlet fans be used with drive arrangements which place the bearings outside of the air stream, such as Arrangement No. 1, No. 2, or No. 8.

D. The quality of any finished coating depends, in part, upon the cleanness and continuity of the metal surface to which it is applied. Any coating will be better when applied to a clean surface without sharp edges or corners. Some coatings are worthless unless applied after only the best preparation. Other coatings may be applied after any preparation, even that usually given for standard paint.

IV. *Variation in Fan Design, Metal Preparation and Coverage for Protective Coatings*

A. The following outlines the possibilities in fan design, metal preparation and coverage for protective coatings. Actual application of the coating is to be strictly in accordance with coating manufacturers' recommendations for a minimum normal treatment. Each step under each part is an improvement or extension of those previously listed and includes the modifications, preparations or parts previously listed.

B. *Modifications in Construction and Design*

1. Standard fan design without modification.
2. Bolts required to provide access or adjustment and normally threaded into the coated surface replaced with studs or bolts having heads continuously welded inside. Inlet and outlets flanged only when specified.
3. Sharp edges, self-tapping screws and permanent threads protruding into the coated surface omitted. Riveted, lock seam and intermittently welded joints here considered acceptable.
4. All hairline cracks and sharp inside corners eliminated by continuously welding, brazing or filling with high melting point solder.
   Wheel hub sealed to the shaft. Housing splits constructed to use external thru bolts. Inlet and outlet flanged and considered as fan interior. Housing split, access door, drain and shaft seal included only when specified.
5. Welds peened or ground reasonably smooth and outside corners ground to approximately 1/16 inch radius in all coated areas.
6. Heavy duty construction to carry coatings of excessive weight, such as thick rubber, lead, etc. shall be completely detailed depending upon actual duty requirements.

C. *Metal Preparation to Precede First Coat*

1. No special preparation other than required for standard commercial finish applied to bare metal or standard finish cleaned of grease and foreign material.
2. Basic surface cleaning of painted or bare metal surfaces. Rust, mill scale, weld spatter, grease, oil, dirt to be removed by wire brushing, chipping, discing, etc. Metal to be cleaned with solvent, vapor degreasing, acid, alkali, di-phase, emulsion or steam. Sheared metal edges to be deburred.
3. Basic surface cleaning as in C.2 above, except all paint must be removed.
4. Wire brush all metal surfaces using power wheel.
5. Phosphatize metal surfaces by dip or spray. (Includes only C.1 and C.3 above).
6. Sandblast metal surface. (Includes only C.1 and C.3 above).
7. Special sandblast—to include preheating to 450°F. Before blasting. Sandblast cold. (Includes only C.1 and C.3 above).

D. *Fan Parts to be Prepared and Coated*

1. Wheel only.
2. Wheel and shaft up to near bearing to be painted as an assembly.
3. All interior surfaces of housing in contact with airstream including inlet, flange faces, shaft seal, drain, etc., as may be required.
4. Parts listed above plus all exterior surfaces of housing.
5. All surfaces of fan including bearing and/or motor pedestal, but not including bearings, coupling, motor, drive, or any other auxiliaries.

V. *Specifying a Protective Coating*

1. A preparation can be completely specified by reference to this AMCA recommended practice as per the following page.

SPECIFICATIONS FOR PROTECTIVE COATINGS FOR FANS

Modification No.	Includes IVB1	IVB2	IVB3	IVB4	IVB5	IVB6	AP 2601 Par. No.	MODIFICATION IN CONSTRUCTION AND DESIGN
1	X						IV-B-1	Standard fan design without modification.
2	X	X					IV-B-2	Bolts required to provide access or adjustment and normally threaded into the coated surface replaced with studs or bolts having heads continually welded inside. Inlet and outlets flanged only when specified.
3	X	X	X				IV-B-3	Sharp edges, self-tapping screws & permanent threads protruding into the coated surface omitted. Riveted, lock seam & intermittently welded joints here considered acceptable.
4	X	X	X	X			IV-B-4	All hairline cracks and sharp inside corners eliminated by continuously welding, brazing or filling with high melting point solder. Wheel hub sealed to the shaft. Housing splits constructed to use external thru bolts. Inlet & outlet flanged & considered as fan interior. Housing split, access door, drain & shaft seal included only when specified.
5	X	X	X	X	X		IV-B-5	Welds peened or ground reasonably smooth and outside corners ground to approximately 1/16 inch radius.
6	X	X	X	X	X	X	IV-B-6	Heavy duty construction to carry coatings of excessive weight, such as thick rubber, lead, etc, shall be completely detailed depending upon actual duty requirements.

Preparation No.	Includes IVC1	IVC2	IVC3	IVC4	IVC5	IVC6	IVC7	AP 2601 Par. No.	METAL PREPARATION TO PRECEDE FIRST COAT
A	X							IV-C-1	No special preparation other than required for standard commercial finish applied to bare metal or standard finish cleaned of grease and foreign material.
B	X	X						IV-C-2	Basic surface cleaning of painted or bare metal surfaces. Rust, mill scale, weld spatter, grease, oil, dirt to be removed by wire brushing, chipping, discing, etc. Metal to be cleaned with solvent, vapor degreasing, acid, alkali, di-phase, emulsion or steam. Sheared metal edges to be de-burred.
C	X	X	X					IV-C-3	Basic surface cleaning as in IV-C-2 above, except all paint must be removed
D	X	X	X	X				IV-C-4	Wire brush all metal surfaces using power wheel.
E	X	X	X		X			IV-C-5	Phosphatize metal surfaces by dip or spray. (Includes only IV-C-1 and IV-C-3 above).
F	X	X	X			X		IV-C-6	Sandblast metal surface. (Includes only IV-C-1 and IV-C-3 above).
G	X	X	X				X	IV-C-7	Special sandblast - to include preheating to 450°F. Before blasting. Sandblast cold. (Includes only IV-C-1 and IV-C-3 above).

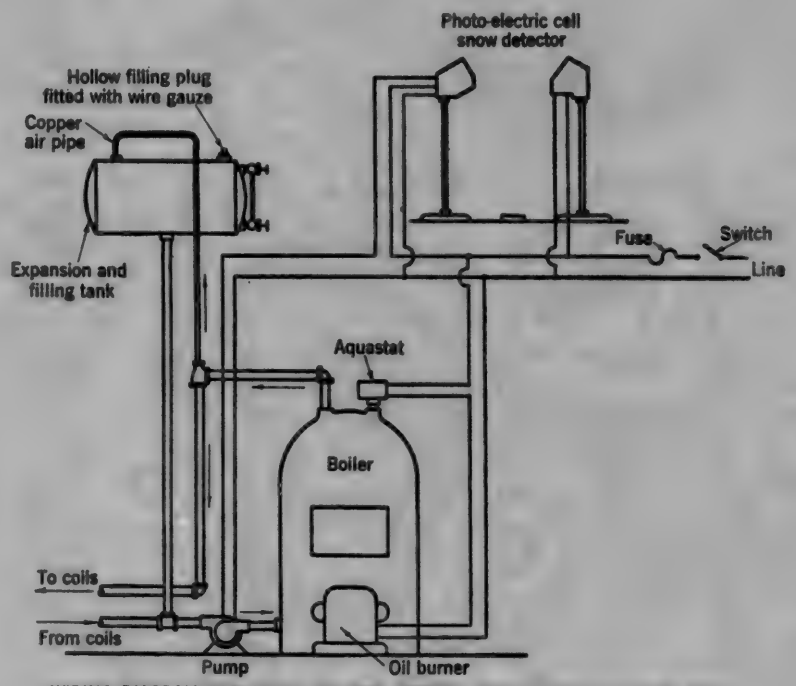
Parts No.	Includes IVD1	IVD2	IVD3	IVD4	IVD5	AP 2601 Par. No.	FAN PARTS TO BE PREPARED AND COATED
11	X					IV-D-1	Wheel only.
22	X	X				IV-D-2	Wheel and shaft up to near bearing to be painted as an assembly.
33	X	X	X			IV-D-3	All interior surfaces of housing in contact with airstream including inlet, flange faces, shaft seal, drain, etc., as may be required.
44	X	X	X	X		IV-D-4	Parts listed above plus all exterior surfaces of housing.
55	X	X	X	X	X	IV-D-5	All surfaces of fan including bearing and/or motor pedestal, but not including bearings, coupling, motor, drive, or any other auxiliaries.

This standard is provided for the selection of the required preparation for protective coating of fans. The callout consists of the standard number followed by the designation for modifications, preparations and parts. See example at right.

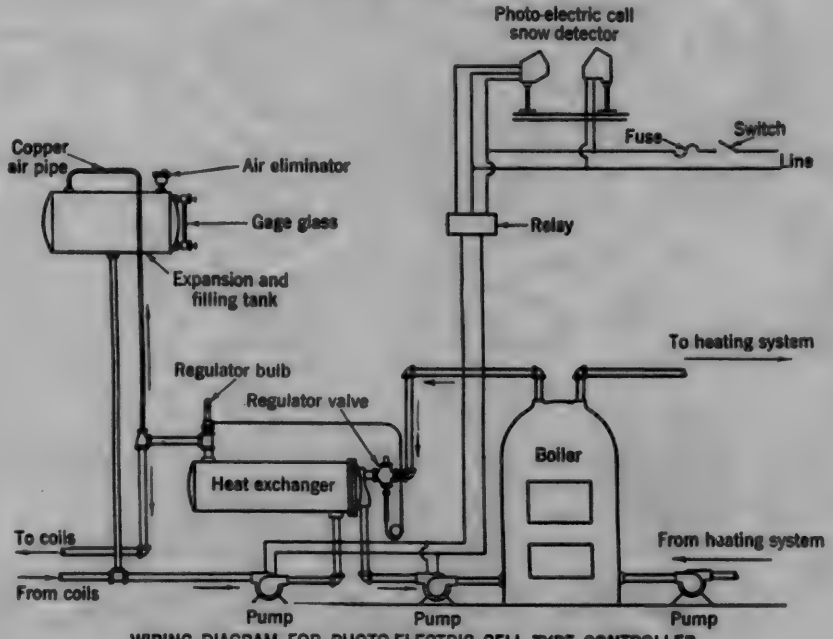
- AMCA Recommended Practice 2601, Preparation of Fans for Protective Coatings.
- Modification number (-6 includes all requirements shown in modification numbers -1 thru -6)
- Preparation number (F includes all requirements shown in preparation numbers A thru F)
- Parts number (33 includes all requirements shown in parts numbers 11 thru 33)

SNOW MELTING SYSTEM

Hookup of Pipe and Controls



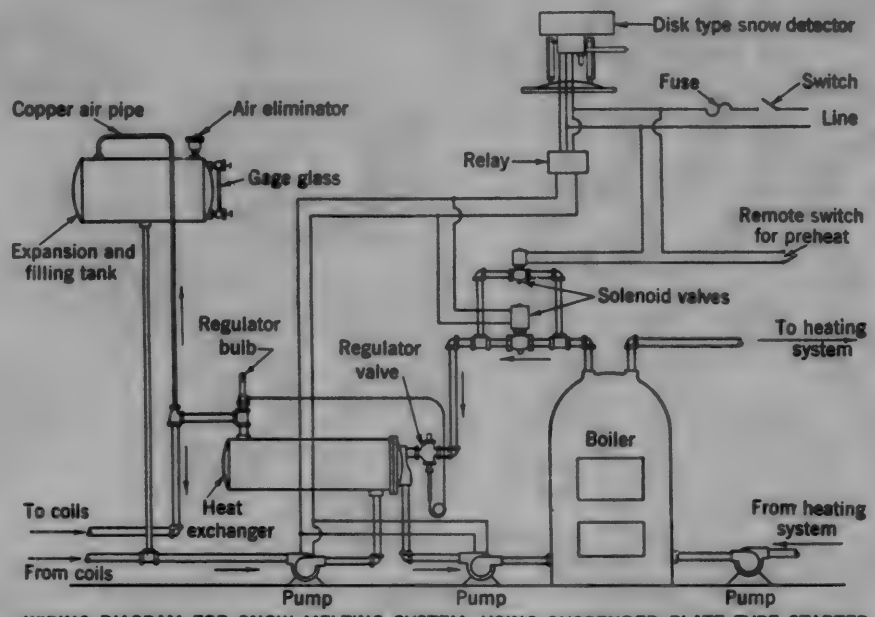
WIRING DIAGRAM FOR SNOW MELTING SYSTEM, USING PHOTO-ELECTRIC CELL TYPE CONTROLLER.



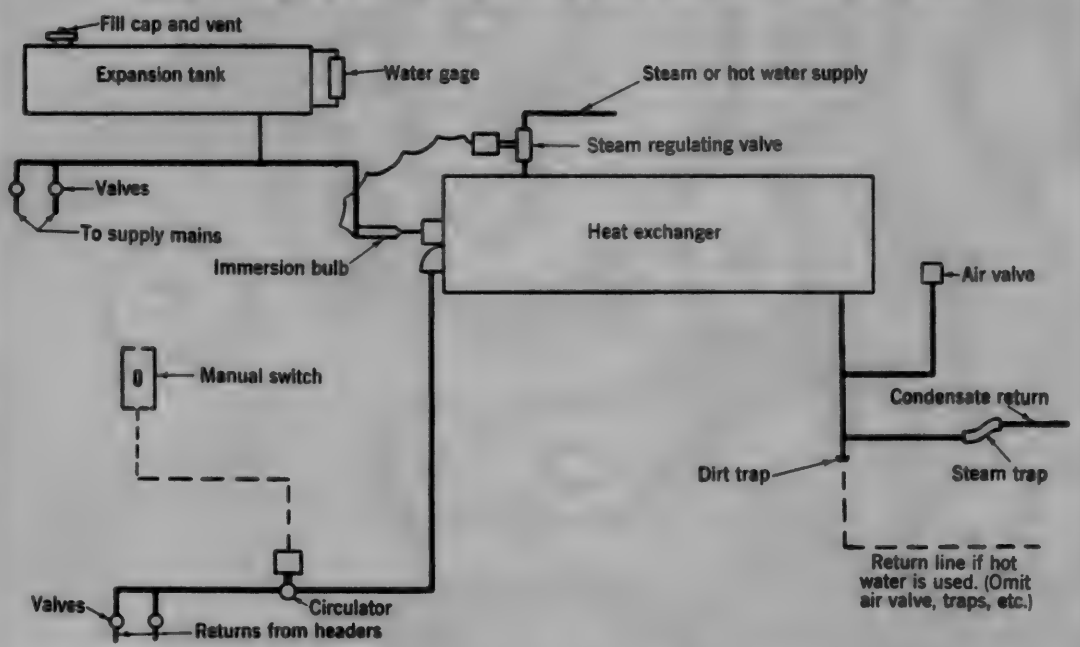
WIRING DIAGRAM FOR PHOTO-ELECTRIC CELL TYPE CONTROLLER.

SNOW MELTING SYSTEM

Hookup of Pipe and Controls



WIRING DIAGRAM FOR SNOW MELTING SYSTEM, USING SUSPENDED PLATE TYPE STARTER.



HEAT EXCHANGER HOOK-UP FOR SNOW MELTING SYSTEM.

Lower diagram from booklet, Snow Melting and Ice Removal, courtesy of American Iron and Steel Institute.

A New Approach to School Design

Power generated by a gas turbine is used for high frequency lighting and for motors. Waste heat from the turbine is used for space heating.

A NEW CONCEPT in school design was announced at a seminar in New York City sponsored by the American Gas Association. It follows through on information presented at a seminar held last June on Improving the Learning Environment (published as a special report, ACH&V, August, 1960), at which time a group of speakers stressed the value of the compact school.

The research and study from which a compact school design was evolved, was conducted by Golemon & Rolfe, engineering and architectural firm, Houston, Tex. This same firm was engaged by AGA to make special studies, and a startling concept of school design was the result. It was reported that considerable savings would result in the new type compact school, where gas turbines were installed to generate low cost power which would be used to operate the air conditioning system, and for high frequency fluorescent lighting.

As an example of the compact school design, D. Dana Price, chief engineer for Golemon & Rolfe, reported on a design for a compact school which would cost $2,163,156 as compared with $2,744,033 for a conventional type school. Although there was a saving of $580,877 on first cost or $41,727 in annual owning and operating costs in favor of the compact design, the cost for purchased electric power for the compact school was $8229 per year. This caused members of school boards in small towns to believe that air conditioned schools were extravagent.

The objective of the recent research was to try to find a mechanical and electrical system for the compact school that would show savings in annual operating cost. The answer was found in the stationary jet engine or gas turbine. The airplane industry had standardized on 400-cycle power and Mr. Price reported that units are available at an attractive price. High frequency generators are also available. Therefore, if gas turbines could be used with high frequency generators to make high frequency power available for lighting, there would be a considerable saving for the compact school.

High frequency lighting results in higher lamp efficiency, makes it possible for standard lamps to be burned at greater wattage, reduces the number of lamps required, cuts heat loss to space from ballasts, eliminates the need for starters, replaces heavy ballasts with light weight condensers, cuts the total amount of power required for the school, reduces lighting installation cost, and the amount of air conditioning required as compared for a space with the same illumination level.

With the gas turbine as a prime mover, power can be generated at any frequency desired. Gases leaving the turbine were about 850 deg F. and a system was considered to use this waste heat for air conditioning and heating. Three systems labeled *A*, *B* and *C*, were considered in this study. Each will now be considered for special analysis.

Analysis of Systems

With System *A*, a gas turbine is used to drive a high frequency generator to provide lighting power, and a 60-cycle generator for motors and electrical outlets. In practice, several small turbines and generators are used paralleling the high frequency generators on one bus, and the 60-cycle generators on another. Exhaust heat from the turbines is run to one waste heat boiler. This design has the advantage of lower first cost because of readily available package units at favorable cost, and the fact that there is some diversity in the event of emergency service requirements. Low pressure steam is passed through an absorption machine where chilled water is generated for the cooling system. Components are simple and equipment maintenance is low.

The same equipment that is described for System *A* is used for System *B*, except that 60-cycle power is generated for lighting and power. This system fails to take full advantage of the gas turbine generator for the compact school.

Solution *C* consists of a gas-fired low pressure boiler supplying low pressure steam to an absorption unit for chilling water. The low pressure steam can also be used to temper the building in the morning or for heating stored water. This system fails to take full advantage of the compact school or of natural gas. Prior to the use of the gas turbine-generator package, this system was considered a good solution to building air conditioning.

Figures compiled show that the annual operating costs for Systems *A* and *B* are $6000 cheaper than the conventional non air conditioned school. Also *A* and *B* solution schools can be built from $446,000 to $467,000 cheaper than the non air conditioned conventional school. The first cost of System *A* is $17,200 less than *B*, and its shows that with *A*, the town will have a higher quality system of lighting and a substantial saving in first cost.

Solution *C* does not meet the requirement that it operate for less money than the conventional school. However, for an additional investment of $20,000 for absorption equipment in a compact school, an annual cost saving of $3000 could be expected over that of a similar school using purchased power.

Just as the compact school produced a better controlled environment school at less first cost than the conventional open school, Solution *A* provides a mechanical system which even with air conditioning, can operate for less money than the non air conditioned school.

SPECIFICATION AND DESIGN SEMINAR.....by Mel Ramsey

Direct Expansion or Chilled Water?

Some think that only water-cooled coils can handle fluctuating capacity demands. Their choice only moves the problem to the water chiller.

WHENEVER REFRIGERATION IS USED, THE QUESTION arises as to whether to transfer heat directly to refrigerant or use water or brine as an intermediary. The many factors which influence the decision must be understood if a logical conclusion is to be reached instead of one based mostly on prejudice.

(In this discussion, systems using "flooded" evaporators are also intended whenever the term "direct expansion" is used.)

Many air conditioning systems in the past satisfied partial load requirements by intermittent operation, but as systems became larger and occupants of air conditioned spaces demanded more comfort, on-off operation was no longer acceptable. Some instances where intermittent operation of refrigeration cannot maintain reasonably good conditions are:

1. A system using any appreciable proportion of continuously supplied outside air entering untreated during periods without refrigeration. Except for those few localities where outside air dew point temperature remains lower than that desired in the conditioned space, the result will be poor humidity control. The worst case would be one using all outside air.

2. A conditioned space in which it is desired to maintain close control of temperature, relative humidity, or both.

3. A conditioned space, large enough or so oriented that the relative refrigeration requirements of all parts do not remain the same. When the sun is on the east exposure its refrigeration requirements relative to the area facing the west will be greater than later in the day. As people gather in a room its proportion of the total refrigeration demand increases.

To provide the conditioning for such spaces requires cooling and dehumidifying coils with face and by-pass dampers, multiple cooling and dehumidifying coils with individual controls, multizone units or some such arrangement.

I have found a number of people who believe that the cooling and dehumidifying coils for such units must be water cooled. They choose water-cooled coils over direct expansion with the feeling that this in itself will reduce the problems due to variation of capacity and demands for operation at very small percentages of full capacity. Actually, their choice of water-cooled coils only moves the problem to the water chiller. If the water chiller is large enough so that a centrifugal compressor, with modulating control to a sufficiently low percentage, or any other type chiller with such features would be used, the problem would be solved.

However, many water chillers use reciprocating compressors with definite and limited capacity steps, similar to the compressor or compressors that would have been used on the direct expansion system. In such cases, the problem for the compressors on the chiller is as bad as that for the compressors on the direct expansion system. In addition, there is the necessity of assuring that freezing of the cooler, with possible serious damage, will not occur at low capacities.

Chillers with reciprocating compressors *can* be designed to operate with a controlled leaving water temperature or a controlled suction pressure, while the load varies from 100% to zero, and during this full range, there need be no change in number of compressors operating nor cycling of unloaders, except as the load changes. (The load in most cases changes slowly, although at a particular moment it may be anything from zero to 100% of capacity.)

However, the features just described may be built into a direct expansion system just as easily and there is no need of separate safety controls to prevent freezing.

Clearly then, the need for modulation of capacity between 100% and zero is not a factor in the choice between direct expansion and chilled water.

Accurate Control of Temperature or Humidity

When very close control of temperature or relative humidity is necessary, accuracy will be improved, it is commonly assumed, by substituting chilled water for direct expansion coils. Several years ago I was of that opinion, but experience has changed it.

Temperature of the evaporating refrigerant can be accurately controlled by a back pressure regulating valve, which maintains pressure in the evaporator at a predetermined value or at some value which is automatically changed to satisfy other conditions. These conditions might be air temperature leaving the coil, relative humidity of the return air, relative humidity at some point in the conditioned space, or any other variable affected by the

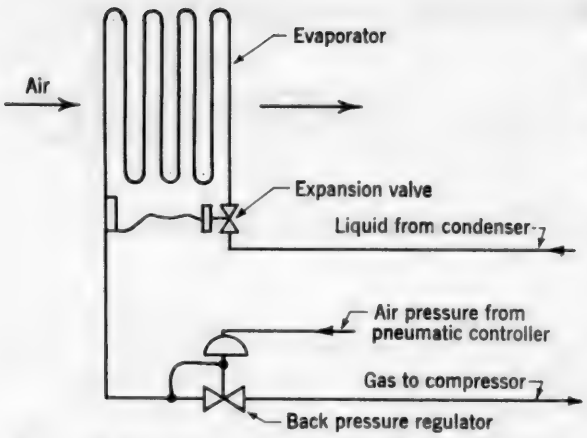


Fig. 1. Back pressure regulator maintains evaporating pressure at a preset value or at a higher value, according to pressure from controller.

temperature of the evaporating refrigerant. If a back pressure regulating valve is properly selected, it will control as well as a water valve. As a matter of fact, the response to a change in temperature is slightly slower with the water-cooled coil because of the heat content of the water in the coil.

About four years ago a system using a direct expansion cooling and dehumidifying coil was installed to maintain a room at 70 deg F ± 0.5 deg and 50% rh ± 1%. An excellent recording instrument shows that the condition is being maintained with less variation. The only part of the system which required adjustment was the valve and water bypass valve for the warm water for the reheat coil. This caused excessive temperature swings because of the heat content of the water which entered the coil at the slightest opening of the water valve. If the automatic water valve had been selected to match more closely the requirements, instead of to match the size of the line in which it was installed, it probably would have been no problem at all.

In the same building are two systems, each using 100% outside air over its direct expansion cooling and dehumdifying coils. Refrigeration is required whenever the outside air enters at 62 deg or higher. When outside air enters at 95 deg db and 75 deg wb, it must leave at about 54 deg db (requiring a 40-deg evaporating temperature). As entering air temperature falls, the leaving temperature may go down to 50 deg db, but not lower. This, of course, requires that the evaporating temperature be above 40 deg part of the time.

Evaporating pressure of each system is controlled by a back pressure regulating valve which keeps the pressure such that evaporation takes place at about 40 deg or higher as a thermostat, in the air leaving the coil, approaches 50 deg. See Fig. 1.

These two systems, also, have been in satisfactory operation since installation about four years ago. Thus, *accuracy of control does not influence my decision toward chilled water for refrigeration.*

Cost of Installation and Operation

The direct expansion system will almost always have a lower installed cost. The system may operate at a higher evaporating temperature because there is no temperature gradient between refrigerant and water. There is no power required for a water pump and no extra refrigeration to compensate for the heat equivalent of the pump brake horsepower. Therefore its operating cost is likely to be less.

If a system is spread over an extensive area, requiring very long refrigerant lines or evaporators at a level too high above the receiver, the first cost or operating cost of a direct expansion system may not be lower. One of the factors in first and operating costs is refrigerant. Extensive refrigerant piping may mean a rather large initial charge. It also increases the chance of refrigerant leaks, although my experience indicates that many people exaggerate this leak problem. If the piping joints are properly made and adequately tested, the chance of leaks is small. However, there is no doubt that the more joints, the greater the chance of a leak and even one undetected leak in a system can lose the whole charge of refrigerant.

Other Factors Favoring or Requiring Chilled Water

1. Although the commonly used refrigerants are not toxic or flammable, they can be harmful under certain conditions. Some of them break down in the presence of flame. Excessive quantities of refrigerant in a limited volume can displace needed air. For reasons such as these, the use of direct expansion is limited or prohibited by law in many localities. Even where there is no such prohibition, the possibility of danger may indicate the desirability of chilled water.

2. Since water chillers are available as factory assembled units, the use of chilled water may be a factor in the elimination of any refrigerant piping at the job. However, as larger packaged conditioners, including those with face and bypass dampers and multizone, are becoming available, this reason for chilled water becomes less valid. More of these packaged, direct expansion conditioners with modulating capacity, from zero to 100%, will become standard items of manufacture.

Conclusion

First and operating costs, safety, and elimination of on-the-job refrigerant piping are factors which I believe should be considered in making a choice between chilled water and direct expansion. Direct expansion will provide as accurate and close control as will chilled water and eliminate the possibility of damage due to freezing.

Only where fairly large water storage is provided, does a chilled water system provide more flexibility of operation than a direct expansion system. Whichever system is used, flexibility comes from the proper arrangements to control net capacity of the compressor, or compressors.

Louis Blendermann on

PLUMBING and PIPING

Water Supply for Lawn Sprinkler Systems

THE various components of a lawn sprinkler system were covered previously. Now attention will be directed to the various means available to provide water in sufficient quantity and pressure for lawn sprinkler system operation. A lawn sprinkler system requires a considerable volume of water at prescribed pressure to produce the desired spray pattern. When the required quantity and pressure do not exist at the site, then means must be considered to meet such needs.

Figure 1 shows the typical application of a lawn sprinkler system for a modern type industrial plant; the water supply line originates in the building. Water can be supplied to a lawn sprinkler system in many ways depending upon the lawn area and the source of water supply.

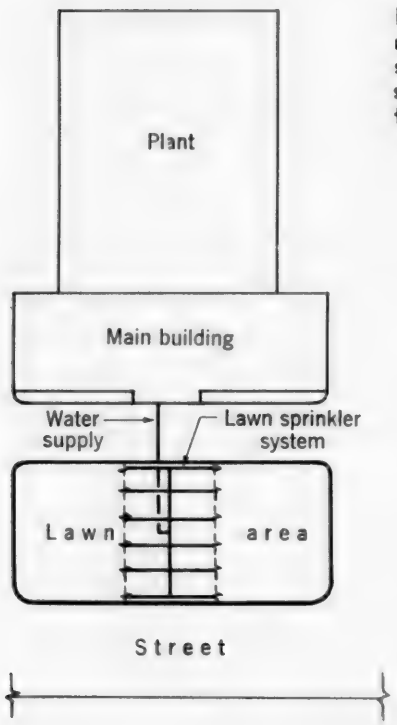


Fig. 1. Arrangement of water supply for a lawn sprinkler system to serve an industrial plant.

Building Supply

Often, a lawn sprinkler system when it is not too extensive, can be supplied from the water supply system in a building. Figure 2 shows such a system. The water supply, in this case, is furnished directly from water mains in the building which also serve the general needs of the building. If the lawn area is relatively small, then the building supply is ideal.

The line is equipped with valves, a pressure reducing valve, a vacuum breaker and a drain valve. The pressure reducing valve permits the prescribed amount of pressure to be applied to the lawn sprinkler system, to assure the correct coverage with the desired spray pattern.

The vacuum breaker provides positive assurance against the back siphonage of water from the lawn sprinkler system, in the event of a drop of pressure in the street water mains serving the building, or a pressure drop in the interior building water mains. Chemicals used for weed or insect control can be harmful to humans. Such compounds applied to the ground surface, mix with the water and are sus-

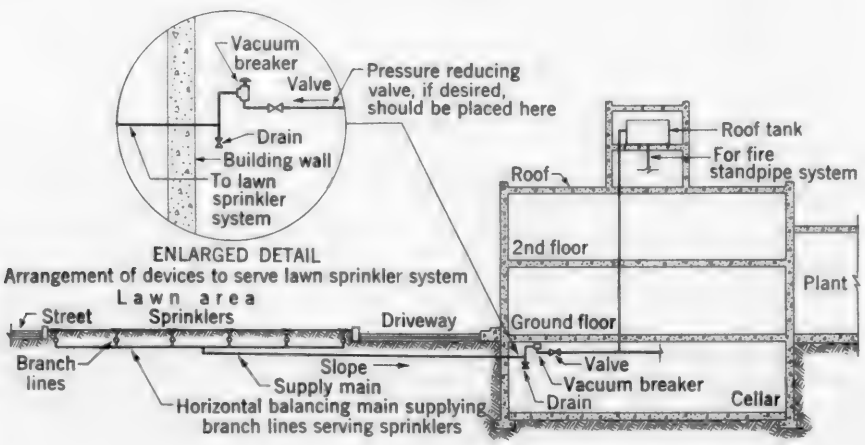


Fig. 2. Water supplied from a roof tank to a lawn sprinkler system. Water may also flow from a water service using only street pressure.

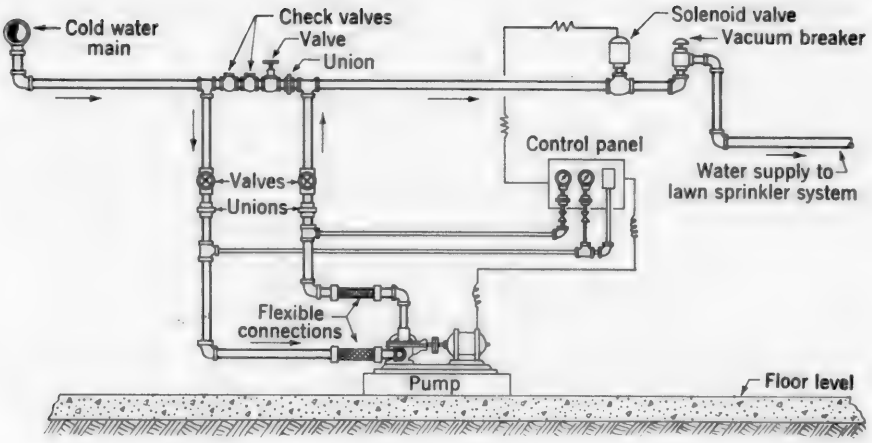


Fig. 3. How a booster pump can provide sufficient water pressure for the operation of a lawn sprinkler system.

pended in solution when the sprinkler system is operating. When a drop in water pressure, or back siphonage occurs, the solution can be sucked into the underground sprinkler piping and thus into the interior piping system where it will contaminate the water supply. This is an extremely dangerous condition and every precaution should be exercised to prevent its occurrence. The necessary protection will be provided by the vacuum breaker.

A roof tank has also been shown in Fig. 2 as a means to supply adequate water and pressure in the building. The water supply to the lawn sprinkler system is furnished in the same manner as when street pressure is used. The control valve, pressure reducing valve, vacuum breaker and drain valve would all be included on the piping arrangement.

The lawn sprinkler piping has been sloped to permit all the water remaining in the underground piping at the end of the season to be drained back into the building and drawn off at the drain valve. This consideration is necessary in areas subject to freezing in the winter months. When the lawn sprinkler system is extensive, the drain valves must be placed in suitable locations in the lawn area as described in a previous article.

When an inadequate water supply and pressure do not exist in the building, other means of fulfilling the needs of the system must be established.

Booster Pump System

When the water supply fluctuates or is slightly inadaquate for the requirements of the lawn sprinkler system, a booster pump of the type illustrated in Fig. 3, may be considered to increase the system pressure.

In this case, the water supply is furnished directly from the building mains to the lawn sprinkler system. The pump is activated when the pressure in the piping drops below prescribed limits for the sprinkler spray pattern. The pump then boosts the pressure for the correct system operation. A pressure reducing valve has not been included on the piping since the pump can be set to furnish any desired pressure. The supply to the lawn sprinkler system is protected by a vacuum breaker to prevent siphonic action.

A booster pump system can be depended upon for efficient operation when it is properly sized and installed. When this type of system is contemplated, it is suggested that the favored pump manufacturer be consulted for recommendations concerning the correct size and piping arrangement.

A solenoid valve has been shown in Fig. 3, in place of a control valve. With this, it is only necessary to push a button to supply water to the sprinkler system.

Booster Pump — Suction Tank Combination

When conditions are such in a building that it is

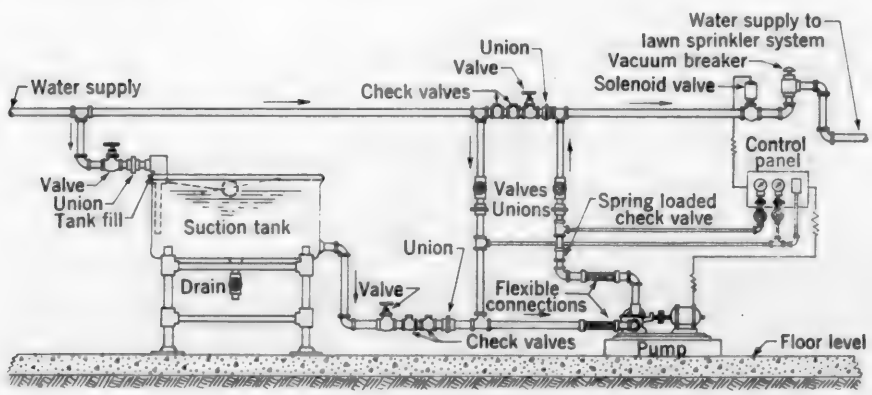


Fig. 4. Use of a booster pump system with a suction tank to provide sufficient water pressure.

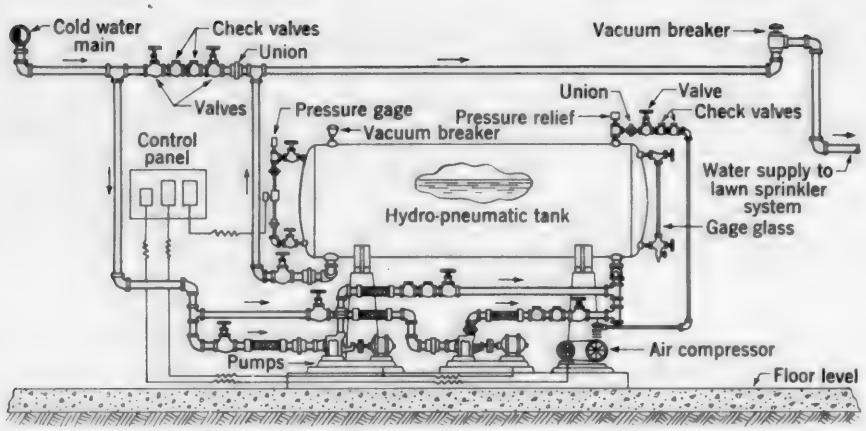


Fig. 5. How a hydro-pneumatic tank system can be used to provide sufficient water pressure for lawn sprinklers.

not feasible to draw water from the building main with pumping equipment, then an arrangement similar to that shown in Fig. 4, can serve the purpose.

This system permits the building water supply to be furnished direct to the lawn sprinkler system when it is of adequate pressure to bypass the pumping equipment. If the pressure is not sufficient, the pumping equipment will operate to boost the pressure in the same manner as described for Fig. 3.

If building conditions are such that a heavy draw of water for the lawn sprinkler system would exceed the capabilities of the building mains, then a suction tank must be used. A heavy demand on the building main can be detrimental to the general water distribution in the building and can cause back siphonage at the upper story levels in the building. The suction tank is sized to meet (1) the specific needs of the sprinkler system and (2) with regard to the duration of the use of sprinklers, the rate at which the suction tank can be replenished with water from the building distribution system. Water in the suction tank is drawn out by the booster pump and supplied to the lawn sprinkler system. A pressure reducing valve has not been included since the pumping equipment will provide the needed pressure. However, if the engineer desires a prescribed pressure, a pressure reducing valve can be installed. The solenoid valve can be included where desired.

This type system offers great flexibility. It can supply water to the lawn sprinkler system by any one of the three methods described. Again, consultation with the pump manufacturer is recommended.

Hydro-Pneumatic Tank System

In buildings where there are fluctuations in water pressure and quantity, it may be necessary to consider the installation of the type system shown in Fig. 5.

The tank is sized to meet the quantity of water needed for the lawn sprinkler system during the time it will operate. Water is drawn from the building mains by the pumping equipment and is supplied to the tank until a prescribed level is reached in the tank. An air compressor provides the pressure needed for the adequate supply of water to the lawn sprinkler system. A pressure reducing valve has not been shown since the water pressure can be regulated in the tank. If however, the engineer wants to increase the pressure in the tank above that needed for the system, he can use a pressure reducing valve to maintain the prescribed pressure. This will assure a positive pressure regardless of the pressure generated in the tank. A vacuum breaker is placed on the water supply to the sprinkler system to safeguard against back siphonage. A vacuum breaker is placed on the tank to prevent its collapse in the event that all the water is drained out. Flexible connections are placed

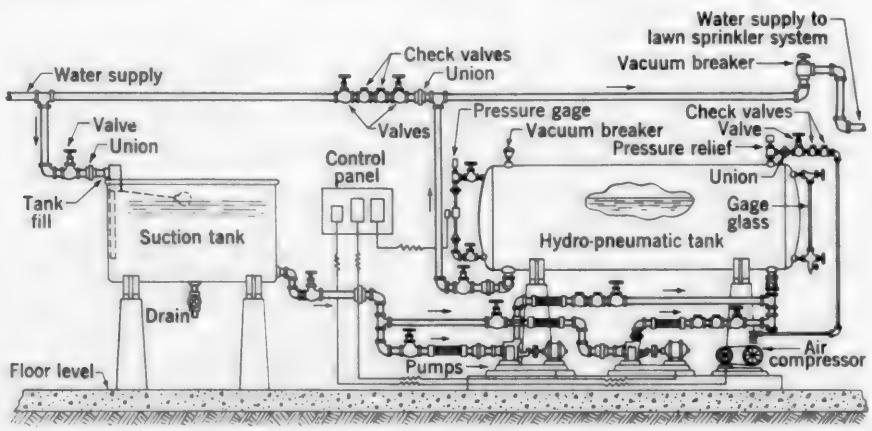


Fig. 6. A hydro-pneumatic tank used with a suction tank to supply water at the proper pressure for lawn sprinklers.

on the inlet and discharge lines of the pumps to eliminate the transmission of pumping noises through the piping system.

The hydro-pneumatic tank system is very efficient and in general serves as a reservoir of water under pressure, independent from the building supply with the exception that the building supply furnishes the water needed initially by the pumping equipment. Since certain pump manufacturers specialize in this type of equipment, they should be consulted for suggestions.

Hydro-Pneumatic Tank System with Suction Tank

When conditions in the building are such that it is not advisable to draw water from the building mains, due to the unbalanced pressures that will be created in the building water distribution system, it becomes necessary to isolate the system required for the lawn sprinkler system. A system of this type is illustrated in Fig. 6.

The suction tank and the hydro-pneumatic tank must be sized to supply the amount of water demanded by he lawn sprinkler system for its period of operation. The suction tank receives it water from the building main and the pumping equipment draws water from the suction tank and delivers it to the hydro-pneumatic tank. Since the pumping equipment does not draw the water directly from the building mains, it does not impose an excessive demand on the building water distribution system.

This system is quite flexible in that water can be supplied directly to the lawn sprinkler system on weekends or at off hours when the building supply is not in active use, providing the water supply and pressure is adequate for the sprinkler system. A vacuum breaker is placed on the water supply to the sprinklers to safeguard the supply against back siphonage. The system is dependable.

Deep Well Pumps

On occasion one may desire to tap an underground water source for lawn sprinklers. Components of this system are illustrated in Fig. 7. A deep well pump delivers the water to a hydro-pneumatic tank. A cushion of air is compressed in the tank to a pressure needed for delivery of water to the sprinklers.

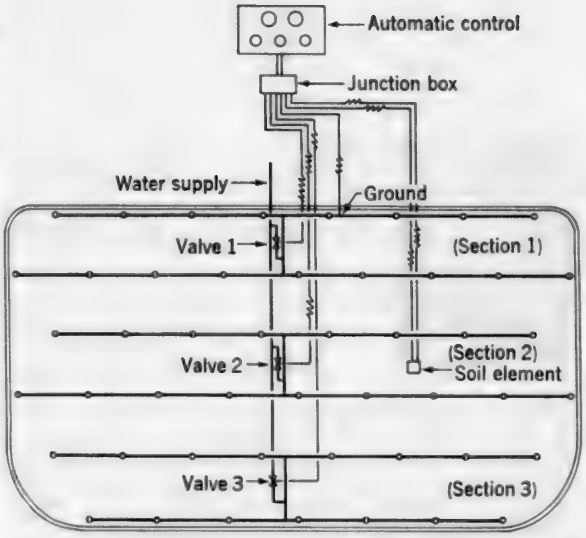


Fig. 8. How automatic controls in the ground can be used to operate lawn sprinklers.

Several arrangements can be used, depending upon the overall scope of the lawn sprinkler system.

There are many arrangements of piping and equipment that can be employed, and there are numerous combinations of pumping equipment and tanks that can be used to meet any specific need. When these systems are carefully designed and installed, they will perform most satisfactory.

Water Hammer Arrestors

Water hammer arrestors have not been covered in this article because most of the systems include a

(Continued on page 136)

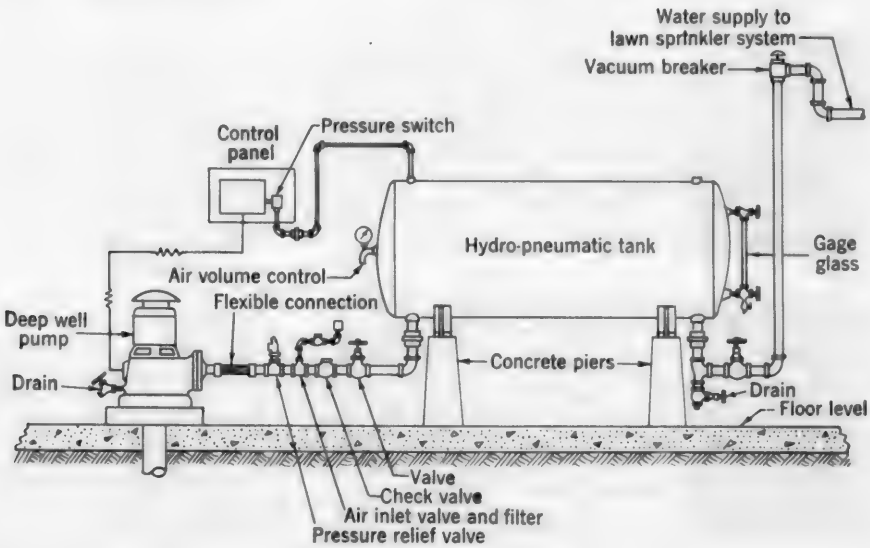


Fig. 7. Use of a hydro-pneumatic tank with a deep well pump to provide water at sufficient pressure.

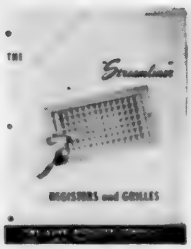
NEW LITERATURE

Use the prepaid yellow postcard in the back of the magazine for securing your copies of these catalogs.

Pump Selector

Standard Pump Div., Worthington Corp., Harrison, N. J., offers Pump Selector G2903 for its Econobloc and Econoped pumps. This pocket-size calculator is designed for fast, accurate pump selection. It includes a friction loss estimator on its reverse side to determine total required head.

Circle **Item 1** on Inquiry Card



Registers and Grilles

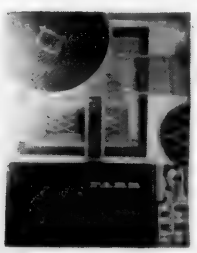
Bulletin S-60, 4-page publication from The Auer Register Co., Cleveland, Ohio, covers its Streamliner line of registers and grilles. Line comprises deluxe, multiple deflection air conditioning registers and return faces. Information includes styles, sizes and prices.

Circle **Item 2** on Inquiry Card

Fire Fighting Equipment

Interior fire fighting equipment is the subject of a 16-page catalog announced by The Fyr-Fyter Co., Dayton, Ohio. Catalog includes engineering and specification data on this equipment which is supplied for protection of commercial, industrial and institutional properties.

Circle **Item 3** on Inquiry Card



Air Filter Handbook

An air filter handbook for the electronics industry is available from Farr Company, Los Angeles, Calif. Bulletin B-100-6 contains all engineering data necessary to size and specify air filters for electronic equipment of any size, and for the room that contains it.

Circle **Item 4** on Inquiry Card

Centrifugal Pumps

New sizes have been added to the Model 3405 line of single-stage, double-suction centrifugal pumps manufactured by Goulds Pumps, Inc., Seneca Falls, N. Y. Complete specifications, interchangeability chart, performance curves and dimensions are shown in 16-page Bulletin 721.6.

Circle **Item 5** on Inquiry Card

Industrial Coolers

Industrial coolers for cooling water and other fluids in closed-system applications are the subject of 4-page Bulletin 108, published by Baltimore Aircoil Co., Inc., Baltimore, Md. This bulletin contains detailed selection information for water cooling applications only.

Circle **Item 6** on Inquiry Card

Steel Smoke Stacks

Steel smoke stacks, made by Koven Fabricators, Inc., Dover, N. J., are the subject of a 4-page bulletin. Useful data include sizes and capacities of stacks for coal and oil burning; anchor bolt determination for self-supporting stacks; and guy wire sizing for guyed stacks.

Circle **Item 7** on Inquiry Card

Home Ventilation Guide

The 12-page Home Ventilation Guide, designed to aid in the selection of the proper exhaust fan and hood-fan for home ventilation, is based upon standards established by the Home Ventilating Institute, Cleveland, Ohio. It also describes a fan performance labeling program.

Circle **Item 8** on Inquiry Card

Canned Pumps

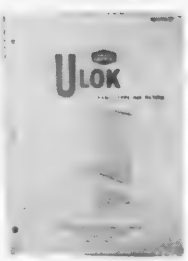
Four-page Bulletin 2050, offered by Chempump Div., Fostoria Corp., Huntington Valley, Pa., describes its new Series G Chempump, a sealless centrifugal, canned pump. Bulletin includes complete performance curves, general specifications and dimensions for the leak-proof units.

Circle **Item 9** on Inquiry Card

Control Valve Sizing

Four-page Bulletin JSC-1 shows how to size Sliding Gate regulators and control valves manufactured by OPW-Jordan Corp., Cincinnati, Ohio. Simplified charts cover steam, liquid and gas service, and tell how to adjust sizing for variations in pressure, temperature and viscosity.

Circle **Item 10** on Inquiry Card



Panel-Type Air Filter

Union Carbide Development Co., a div. of Union Carbide Corp., New York, N. Y., offers a 4-page bulletin detailing its newly developed Ulok panel-type air filter. Filter is reported to provide up to 100% longer service life than other throw-away types. Performance data included.

Circle **Item 11** on Inquiry Card

Induction Unit Selector

A circular selector has been developed by Carrier Air Conditioning Co., Syracuse, N. Y., to help engineers select high velocity induction air conditioning units. Information it provides includes size, nozzle pressure, total capacity and cfm of unit required to condition a given space.

Circle **Item 12** on Inquiry Card

Use the prepaid yellow postcard in the back of the magazine for securing your copies of these catalogs.

Electrical Equipment Testing

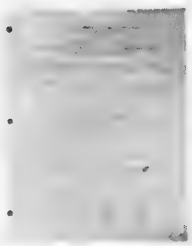
A 16-page, illustrated catalog, No. 10-1.3, describing an enlarged line of instruments for installation, proof-testing and maintenance of electrical equipment is announced by Associated Research, Inc., Chicago, Ill. Applications of the various instruments are included.

Circle **Item 13** on Inquiry Card

Hot Water Converters

Twenty-page Bulletin 71, published by Niagara Weldments Inc., Niagara Falls, N. Y., presents a new line of NiaWel hot water converters designed specifically for space heating service. Included is a graphically-illustrated method for selecting the correct shell and heating surface.

Circle **Item 14** on Inquiry Card



Thermal Insulation

A new specification for flexible unicellular thermal insulation material, in both sheet and tube (for pipe covering) form, has been approved and issued by manufacturers of the material. Copies are available from Unicellular Insulation Manufacturers Task Force, New York, N. Y.

Circle **Item 15** on Inquiry Card

Fire Protection Equipment

Fire protection equipment for all types of buildings is the subject of 44-page Catalog No. 60. Published by Elkhart Brass Mfg. Co., Inc., Elkhart, Ind., the comprehensive catalog describes cabinets, hose racks and reels, valves, hose and couplings, nozzles, and many others.

Circle **Item 16** on Inquiry Card

Electric Motors

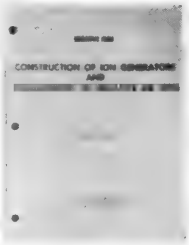
Eight-page Bulletin 2651, available from The Louis Allis Co., Milwaukee, Wis., outlines an extensive line of electric motors to meet a broad field of application requirements. Bulletin illustrates and describes 23 types of motors with construction details, applications and ratings.

Circle **Item 17** on Inquiry Card

Infra-Red Comfort Heaters

A new line of electric infra-red comfort heaters for direct radiant heating of hard-to-heat indoor and outdoor areas is described in 8-page Bulletin CH-100, published by Fostoria Corp., Fostoria, Ohio. Principles, advantages and typical applications are discussed.

Circle **Item 18** on Inquiry Card



Negative Ion Generators

An 8-page booklet, CE-860, which tells how to build negative ion generators and measure their ion output, is available from Lamp Div., Westinghouse Electric Corp., Bloomfield, N. J. Interest in ions, which supposedly have a beneficial effect on humans, prompted publication.

Circle **Item 19** on Inquiry Card

Instruments and Filters

A 44-page publication, entitled "Dust Topics," is offered by Gelman Instrument Co., Chelsea, Mich. This booklet describes new instruments and filters for use in dust surveys, air pollution analysis, radiation protection and special sub-micron filtration apparatus.

Circle **Item 20** on Inquiry Card

Wire-Reinforced Rubber Pipe

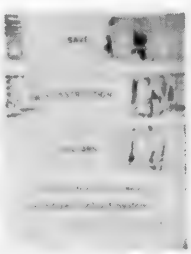
General Rubber Corp., Tenafly, N. J., announces 4-page Bulletin 866 covering its recently acquired line of SoundZorber wire-reinforced flexible rubber pipe. Line is reported to give excellent results in reducing, and even eliminating, noise and vibration disturbance in pipe lines.

Circle **Item 21** on Inquiry Card

Self-Cleaning Strainers

Leslie Co., Lyndhurst, N. J., announces the availability of a new strainer catalog, and the adoption of a simplified strainer selection procedure. The 12-page catalog, No. 6008, describes self-cleaning strainers for steam, air, gas and liquids, including cryogenic service.

Circle **Item 22** on Inquiry Card



The Single Contract System

Contract awarding authorities from private industry and from all levels of government are quoted as supporting the single contract method of construction in a new, 16-page brochure published by the Associated General Contractors of America, Washington, D. C.

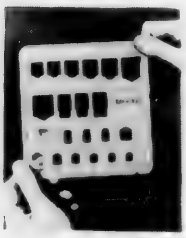
Circle **Item 23** on Inquiry Card

Air Control Valves

A 6-page catalog issued by Hoffman Valves, Inc., Dayton, Ohio, is planned as a quick and easy reference to air control valves manufactured by the company. Bulletin 60-2 shows construction features, lists specifications, and includes section on installation and maintenance.

Circle **Item 24** on Inquiry Card

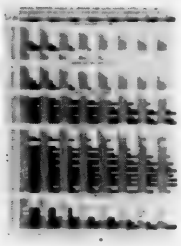
Use the prepaid yellow postcard in the back of the magazine for securing your copies of these catalogs.



Dual Duct Layouts

A template for dual duct air conditioning layouts is announced by Buensod-Stacey Corp., New York, N. Y. Template has both ¼ and ⅛-inch scales, and openings are provided in both scales for the exact reproduction of all available air mixing units, from 60 to 4000 cfm.

Circle **Item 25** on Inquiry Card



Commercial Water Heaters

Accurate selection of a commercial water heater to supply enough sanitizing rinse water for various classifications of commercial dishwashing machines is simplified by the use of an equipment selection chart offered by Ruud Manufacturing Co., Kalamazoo, Mich.

Circle **Item 26** on Inquiry Card

Protective Coatings

The solution to a wide variety of corrosion and deterioration problems is presented by Tar Products Div., Koppers Co., Inc., Pittsburgh, Pa., in an 8-page bulletin on Bitumastic cold-applied protective coatings. Bulletin lists recommended coating for various types of installations.

Circle **Item 27** on Inquiry Card

Products and Services

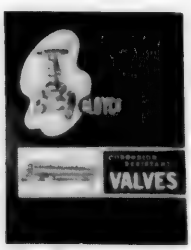
A 16-page buyer's guide to Chase products and services is available from Chase Brass & Copper Co., Waterbury, Conn. This directory includes information on aluminum, brass, bronze, copper, nickel, and other metals; also, a detailed listing of mill products and specialties.

Circle **Item 28** on Inquiry Card

Fractional Horsepower Motor

Reliance Electric & Engineering Co., Cleveland, Ohio, offers an 8-page bulletin on its fractional horsepower Duty Master motor. Bulletin B-2514 describes advantages (new ventilation system, reduced weight) of this motor, and illustrates construction and design details.

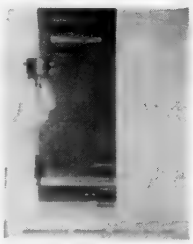
Circle **Item 29** on Inquiry Card



Corrosion-Resistant Valves

Sixteen-page Bulletin No. 7, illustrating and describing the Aloyco line of corrosion-resistant valves, is offered by Alloy Steel Products Co., Linden, N. J. Chemical composition ranges and minimum mechanical properties are especially valuable sections of the bulletin.

Circle **Item 30** on Inquiry Card



Temperature Regulating Devices

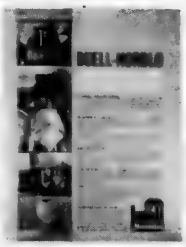
Temperature regulating devices capable of routinely controlling air or liquid temperatures within a fraction of a degree are described in Catalog 360 by American Instrument Co., Inc., Silver Spring, Md. The various components covered are available separately or in assemblies.

Circle **Item 31** on Inquiry Card

Submersible Turbine Pumps

A 4-page bulletin on submersible turbine pumps is offered by The Deming Co., Salem, Ohio. Bulletin No. 6730 (Section No. 50) presents size and capacity tables, installation diagrams, performance data, and the heavy-duty pumps' internal parts and operation.

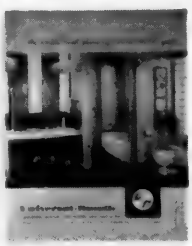
Circle **Item 32** on Inquiry Card



Dust Collection Systems

Buell Engineering Co., Inc., New York, N. Y., announces a 4-page bulletin describing its complete line of Buell-Norblo dust collecting, recovery and classifying equipment. Areas of application include air pollution, recovery of material from waste gases, and employee comfort.

Circle **Item 33** on Inquiry Card



Plumbing Fixtures

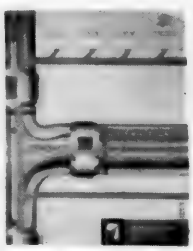
Universal-Rundle Corp., New Castle, Pa., announces a 40-page catalog of plumbing fixtures and trimmings for commercial, industrial and residential use. Included are bathtubs, lavatories, water closets, urinals, drinking fountains, sinks, and luxury trim fittings.

Circle **Item 34** on Inquiry Card

Shower Enclosures

Permalume shower enclosures are manufactured by Shower Door Company of America, Atlanta, Ga., and are backed by a 17-year unconditional guarantee. Twenty-eight page Catalog 155 illustrates and describes all of the company's many models of shower doors and tub enclosures.

Circle **Item 35** on Inquiry Card



Glass Drainline

A 16-page catalog, giving detailed information on Pyrex brand "double-tough" drainline, is published by Corning Glass Works, Corning, N.Y. The illustrated bulletin, PE-30, contains product and property data on the corrosion-resistant glass system for disposal of chemical wastes.

Circle **Item 36** on Inquiry Card

DEGREE-DAYS FOR JANUARY, 1961

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city

AIR CONDITIONING, HEATING AND VENTILATING's 33rd Year of Publication of Monthly Degree-Day Data

City	January			Season to Jan. 31, incl., from Sept. 1		
	1961	1960	Normal	1961	1960	Normal
Abilene, Texas (A)	749	639	673	1807	1803	1771
Albany, New York (A)	1530	1307	1318	4144	3742	3877
Albuquerque, New Mexico (A)	956	987	970	2719	2712	2727
Alpena, Michigan (C)	1607	1366	1358	4658	4433	4185
Anchorage, Alaska (A)	1359	1482	1612	5242	5685	5889
Asheville, North Carolina (C)	971	800	794	2650	2353	2427
Atlanta, Georgia (A)	814	635	632	1999	1735	1757
Atlantic City, New Jersey (C)	1174	865	905	2918	2418	2502
Augusta, Georgia (A)	722	588	521	1844	1534	1356
Baltimore, Maryland (C)	1043	841	880	2661	2303	2417
Billings, Montana (A)	1010	1291	1305	3479	4058	4044
Binghamton, New York (C)	1422	1067	1218	3919	3119	3635
Birmingham, Alabama (A)	798	622	623	1966	1674	1751
Bismarck, North Dakota (A)	1437	1668	1730	4780	5143	5188
Block Island, Rhode Island (A)	1182	983	1026	3095	2748	2962
Boise, Idaho (A)	975	1268	1169	3205	3991	3509
Boston, Massachusetts (A)	1231	1048	1113	3266	2942	3121
Buffalo, New York (A)	1435	1188	1225	3955	3475	3649
Burlington, Iowa (A)	1307	1203	1271	3534	3609	3605
Burlington, Vermont (A)	1728	1497	1460	4689	4288	4319
Cairo, Illinois (C)	986	820	856	2558	2362	2321
Charleston, South Carolina (C)	563	460	445	1398	1147	1103
Charlotte, North Carolina (A)	825	691	704	2138	1896	1978
Chattanooga, Tennessee (A)	928	709	725	2448	2046	2105
Cheyenne, Wyoming (A)	1108	1214	1225	3833	4114	4065
Chicago, Illinois (A)	1284	1137	1243	3493	3442	3595
Cincinnati, Ohio (C)	1072	846	942	2791	2520	2653
Cleveland, Ohio (A)	1336	1039	1132	3800	3128	3303
Columbia, Missouri (A)	1095	1033	1091	2909	3047	3058
Columbia, South Carolina (A)	728	603	538	1858	1602	1446
Columbus, Ohio (C)	1247	960	1051	3324	2905	3046
Concord, New Hampshire (A)	1562	1287	1392	4410	3834	4231
Concordia, Kansas (C)	1084	1243	1144	2991	3385	3192
Dallas, Texas (A)	708	628	607	1629	1584	1477
Denver, Colorado (A)	1026	1151	1125	3458	3551	3473
Des Moines, Iowa (A)	1328	1352	1330	3666	3945	3785
Detroit, Michigan (A)	1291	1110	1203	3576	3388	3528
Devils Lake, North Dakota (C)	1791	1903	1866	5469	5839	5661
Dodge City, Kansas (A)	977	1112	1076	2838	3169	3027
Dubuque, Iowa (A)	1466	1376	1414	4192	4267	4179
Duluth, Minnesota (A)	1769	1686	1696**	5299	5444	5229**
El Paso, Texas (A)	735	691	670	1984	1736	1756
Ely, Nevada (A)	1170	1418	1302	3947	4454	4166
Escanaba, Michigan (C)	1538	1371	1473	4500	4420	4529
Evansville, Indiana (A)	1097	874	939	2969	2689	2654
Fairbanks, Alaska (A)	2078	2134	2319	7788	8100	8248
Fargo, North Dakota (A)	1803	1762	1795	5311	5268	5333
Fort Smith, Arkansas (A)	902	785	775	2209	2121	2048
Fort Wayne, Indiana (A)	1332	1128	1200	3731	3449	3565
Fort Worth, Texas (A)	740	643	690	1696	1631	1512
Fresno, California (A)	694	556	629	1840	1479	1640
Galveston, Texas (C)	484	384	356	946	895	758
Grand Junction, Colorado (A)	1099	1183	1271	3227	3515	3564
Grand Rapids, Michigan (A)	1359	1175	1287	3819	3700	3879
Green Bay, Wisconsin (A)	1520	1359	1516	4498	4489	4551
Greensboro, North Carolina (A)	935	776	806	2552	2284	2319
Greenville, South Carolina (A)	781	680	673	2038	1917	1873
Harrisburg, Pennsylvania (A)	1232	961	1051	3371	2878	3022
Hartford, Connecticut (A)	1343	1163	1178	3754	3346	3444
Havre, Montana (C)	1157	1512	1513	4219	4660	4753
Helena, Montana (A)	1158	1522	1469	4172	4856	4716
Houston, Texas (C)	473	404	378	1002	973	843
Huron, South Dakota (A)	1725	1634	1597	4955	4777	4600
Indianapolis, Indiana (A)	1275	1020	1122	3538	3218	3263
Jackson, Mississippi (A)	748	606	535	1721	1585	1417
Juneau, Alaska (A)	1062	1146	1203	4059	4148	4515
Kansas City, Missouri (A)	1026	1049	1085	2787	2914	2960
Knoxville, Tennessee (A)	947	742	760	2491	2133	2214
La Crosse, Wisconsin (A)	1504	1349	1528	4230	4288	4428
Lander, Wyoming (A)	1322	1450	1494	4445	4720	4803
Lewiston, Maine (O)	1526	1259	1452	4337	3818	4289

a) Data not available.
* Figures based on Central Park readings.
** Figures based on City office readings.

Normal figures in this table are based on 30-year period covering 1921 to 1950, inclusive, as compiled and published by the U. S. Weather Bureau.

Figures in this table, with two exceptions, based on local weather bureau reports. Exceptions are Utica and Lewiston, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Co., Utica, N. Y., and Norman E. Ross, Bursar, Bates College, Lewiston, Me., respectively.

Degree-Days for January, 1961 (Concluded)

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city

AIR CONDITIONING, HEATING AND VENTILATING's 33rd Year of Publication of Monthly Degree-Day Data

City	January			Season to Jan. 31, incl., from Sept. 1		
	1961	1960	Normal	1961	1960	Normal
Lincoln, Nebraska (C)	1199	1344	1240	3297	3670	3483
Little Rock, Arkansas (A)	894	733	719	2269	1944	1898
Los Angeles, California (C)	116	319	328	467	489	779
Louisville, Kentucky (A)	1115	830	933	3039	2495	2666
Lynchburg, Virginia (A)	1005	837	846	2741	2423	2471
Macon, Georgia (A)	680	528	497	1660	1409	1321
Madison, Wisconsin (A)	1484	1355	1417	4279	4233	4124
Marquette, Michigan (C)	1511	1349	1435	4484	4477	4446
Memphis, Tennessee (A)	829	715	725	2211	1975	1973
Meridian, Mississippi (A)	758	611	561	1787	1616	1517
Milwaukee, Wisconsin (A)	1407	1259	1336	4121	3963	3947
Minneapolis, Minnesota (A)	1641	1467	1562	4779	4507	4552
Moline, Illinois (A)	1355	1212	1296	3738	3707	3722
Montgomery, Alabama (A)	749	541	517	1757	1414	1381
Nashville, Tennessee (A)	977	769	778	2565	2200	2150
New Haven, Connecticut (A)	1275	1048	1113	3454	2999	3258
New Orleans, Louisiana (C)	480	390	341	932	912	770
New York, New York (C)	1149*	941	995	2953*	2625	2766
Newark, New Jersey (A)	1185	940	1039	3110	2622	2951
Norfolk, Virginia (A)	921	713	729	2305	1901	1986
North Platte, Nebraska (A)	1182	1400	1271	3701	4226	3835
Oak Ridge, Tennessee (C)	976	764	834	2603	2171	2421
Oakland, California (A)	549	497	552	1612	1304	1629
Oklahoma City, Oklahoma (A)	885	880	843	2242	2394	2210
Omaha, Nebraska (A)	1245	1370	1302	3404	3789	3670
Parkersburg, West Virginia (C)	1114	880	949	3037	2695	2773
Peoria, Illinois (A)	1351	1171	1240	3748	3542	3552
Philadelphia, Pennsylvania (C)	1085	868	933	2724	2414	2557
Phoenix, Arizona (A)	325	506	425	939	993	980
Pittsburgh, Pennsylvania (C)	1176	910	992	3151	2719	2882
Pittsfield, Massachusetts (A)	1540	1318	1358	4360	3951	4203
Portland, Maine (A)	1532	1273	1373	4358	3852	4149
Portland, Oregon (C)	577	853	791	2141	2435	2391
Providence, Rhode Island (A)	1274	1106	1125	3505	3147	3320
Pueblo, Colorado (A)	1040	1282	1104	3177	3595	3383
Raleigh, North Carolina (A)	878	721	691	2355	2073	1857
Rapid City, South Dakota (A)	1158	1266	1361	3790	4212	4163
Reading, Pennsylvania (C)	1184	932	1017	3176	2714	2883
Red Bluff, California (A)	632	645	617	1632	1444	1559
Reno, Nevada (A)	970	1156	1048	3352	3637	3386
Richmond, Virginia (A)	971	807	828	2627	2308	2360
Rochester, New York (A)	1410	1244	1249	3872	3635	3722
Roswell, New Mexico (A)	942	848	787	2739	2338	2202
Sacramento, California (C)	670	542	614	1666	1470	1594
St. Joseph, Missouri (A)	1161	1169	1017	3156	3344	2826
St. Louis, Missouri (C)	1021	940	983	2680	2695	2686
Salt Lake City, Utah (A)	1116	1212	1194	3370	3760	3473
San Antonio, Texas (A)	523	465	462	1135	1202	1062
San Diego, California (A)	136	309	317	551	493	795
Sandusky, Ohio (C)	1287	1085	1122	3464	3193	3238
San Francisco, California (C)	486	425	462	1487	1024	1343
Sault Ste. Marie, Michigan (A)	1677	1444	1587	4892	4757	4927
Savannah, Georgia (A)	593	473	424	3162	1227	1099
Scranton, Pennsylvania (A)	1422	1109	1141	3991	3397	3395
Seattle, Washington (C)	568	701	753	2223	2397	2435
Sheridan, Wyoming (A)	1168	1320	1392	4009	4507	4437
Shreveport, Louisiana (A)	661	598	550	1579	1563	1398
Sioux City, Iowa (A)	1443	1464	1423	3868	4206	4131
Spokane, Washington (A)	1067	1374	1243	3795	4376	3948
Springfield, Illinois (A)	1248	1082	1116	3372	3203	3114
Springfield, Missouri (A)	1041	932	1001	2775	2811	2834
Syracuse, New York (A)	1427	1241	1225	3873	3580	3565
Toledo, Ohio (A)	1313	1113	1197	3804	3563	3561
Topeka, Kansas (C)	1113	1136	1088	3013	3242	2979
Trenton, New Jersey (C)	1188	932	1004	3112	2669	2856
Tulsa, Oklahoma (A)	943	857	856	2238	2274	2238
Utica, New York (O)	1166	1172	1248	3349	3336	3785
Valentine, Nebraska (A)	1264	1347	1361	4003	4398	4070
Walla Walla, Washington (C)	809	1171	1023	2805	3303	2989
Washington, D. C. (A)	1081	824	884	2837	2319	2488
Wichita, Kansas (A)	1036	1050	1023	2756	2886	2786
Williston, North Dakota (C)	1414	1695	1705	4696	5197	5200
Winnemucca, Nevada (A)	966	1238	1153	3459	4076	3748
Yakima, Washington (A)	996	1318	1181	3535	3871	3650

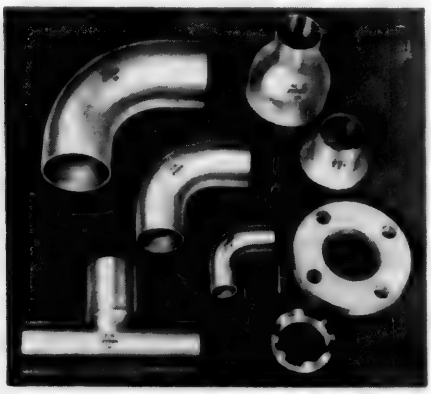
For footnotes, see page 95.

NEWS OF EQUIPMENT AND MATERIALS

Use the convenient prepaid yellow postcard in the back of the magazine for securing more information about new equipment and materials described in this department.

Tangential Fittings

Pypon tangential fittings, introduced by Flowline Corp., New Castle, Pa., are joined to pipe using equipment which is normally available in any shop, according to the manufacturer. Fittings are designed for nominal temperature, low pressure process piping. The line includes elbows, returns, tees, caps, stub ends and reducers in stainless steel or aluminum, ½ through 4-inch pipe sizes, Schedule 5S and 10S. Rotating or fixed carbon steel flanges are also supplied



Fittings are supplied with long tangents which permits joining them to pipe by rolled-in flanged assemblies, fillet welding, soft soldering, silver brazing or butt welding. It is stated that their use, with lightweight or featherweight pipe instead of Schedule 40 pipe, provides greater flow area, substantially reduces weight, and effects savings of as much as 50% in material costs.

More Information? Circle Item 37 on Inquiry Card.

Continuous-Duty Booster Pump

A compact pump designed to boost system pressure right in the distributing line is announced by Peerless Pump, Hydromechanics Div., Food Machinery and Chemical Corp., Los Angeles, Calif. Tradenamed Hydro-Boost, the pump is a submersible, turbine type unit. It is designed for continuous duty and provides a ready solution to adding a booster station on lines requiring additional pressure to serve newly developed areas.

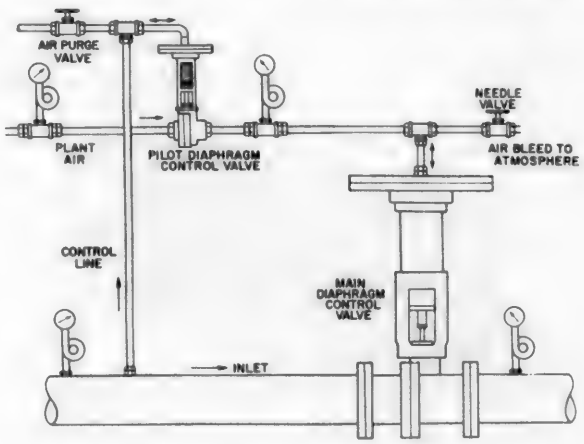
Available in a complete range of sizes, booster is offered in capacities to 8,000 gpm, heads to 1000 ft, with motors to 350 hp. It can be placed in lines ranging up to 16 inches diameter.

According to the manufacturer, the booster has been built to high performance standards.

More Information? Circle Item 38 on Inquiry Card.

Back Pressure Regulators

Four- and six-inch sliding gate air-operated back pressure regulators are available from OPW-Jordan Corp., Cincinnati, Ohio. They have capacities up to 50,000 pounds of steam per hour or 25,000 gpm of water. Sliding gate seats used in both pilot and main



valve give accurate regulation, tight shut-off and minimum maintenance, the company states. Sliding gate seats are self-cleaning and self-lapping, reduce maintenance problems and provide close control.

System is suitable for pressures to 250 psi WSP and temperatures to 500 deg F. The main valve is cast iron with 125-lb ASA flanges, or ductile iron with 150-lb or 300-lb ASA flanges. The pilot is a standard screwed end control valve with special sliding gate seats.

More Information? Circle Item 39 on Inquiry Card.

Steam Specialties Offered

Cast-iron steam and oil separators, brass expansion joints, and sediment separators are added to the product line of Strong Steam Specialties, Conneaut, Ohio. The low-pressure cast iron separators, available in both horizontal and vertical molds, will supplement the company's line of high-pressure separators.

Separators are produced in sizes ranging from 1½ to 8 inches, designed for condensate or oil removal where maximum pressure does not exceed 250 psi. A horizontal model is also available in sizes from 1½ to 12 inches. The 250-psi horizontal unit features a cast iron drip pocket serving as a combination collector for both condensate and sediment.

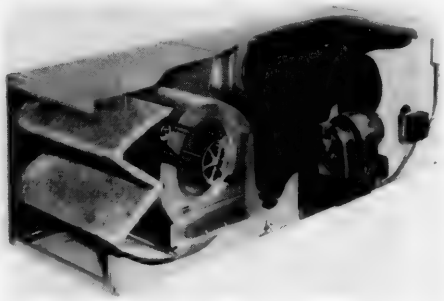
Brass expansion joints are screwed, semi-guided types designed for installation on steam or hot water heating lines, interior piping, hot water lines, or air, oil or gas service applications. Maximum working pressures are 125 lb for saturated steam; 200 lb for cold water, oil and gas.

More Information? Circle Item 40 on Inquiry Card.

Forced Air Oil Furnaces

Horizontal (Stowaway) forced air oil furnaces, available from Lennox Industries, Inc., Marshalltown, Iowa, can be suspended from a ceiling, installed on a platform or shelf, or installed in crawl space areas. Direct expansion evaporators can be added to accomplish all-season air conditioning. Units are particularly adapted to overhead installation in gasoline service stations.

Heat exchanger is made of heavy-gage steel of con-



tinuous edgeweld construction and designed for easy access to interior for cleaning. Oil burner is the company's own, built to match the heat exchanger.

Furnished with the unit are a primary stack control, barometric draft regulator, fan and limit controls, and a low voltage, mercury bulb, heat accelerated thermostat. Belt driven blower has all moving parts resiliently mounted. Cabinet comes in two sections with all wiring factory mounted.

More Information? Circle Item 42 on Inquiry Card.

Machine Makes Endless Duct

Endless metal pipe is manufactured in gages from 0.015 to 0.037 inch and diameters from 3 to 36 inches by Spiro 403B tubeforming machine, a product of Spiro U.S.A., Inc., Chicago, Ill. In practical use, standard lengths up to 20 ft are turned out at one cent a pound, the company states.

Machine is fully automatic. From feeding the strip stock through the manufacturing process to stacking, only one operator is required. Sheet metal contrac-

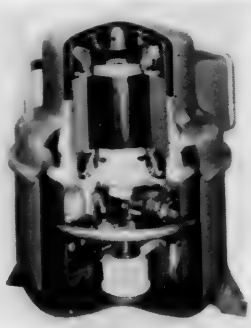
tors are said to experience considerable savings through reduced inventory because only two widths of strip are employed for all dimensions of pipe. Diameters can be changed in a few minutes to make spiral tubes with positive lock joints from aluminum, copper, galvanized steel and other metals.

According to the manufacturer, pipe made with this machine has added strength, rigidity, and low friction loss. Its applications are in air conditioning, heating, ventilation, fume and dust removal, blowpipe systems, irrigation, conveyor systems and similar functions.

More Information? Circle Item 43 on Inquiry Card.

Lightweight Hermetic Compressor

A new 5 and 7½ hp hermetic compressor for use in the company's package equipment is announced by The Trane Company, La Crosse, Wis.



The refrigeration compressor—called Model D—is a short stroke, large bore machine. All connecting rods and pistons are aluminum to reduce unbalance. The 5 hp model has three cylinders; the 7½ hp has four cylinders.

Among the features listed for the Model D by the manufacturer are:

Crankshaft and rotor statically and dynamically balanced as an assembly.

Crankshaft constructed of ductile iron, the main and pin journals induction hardened and valves plated —all to reduce wear.

An anti-slugging valve which releases pressure immediately when liquid gets into cylinders.

Internal vibration isolators which float the basic compressor assembly within the stationary outer shell, thereby isolating vibrations where they originate, and eliminating the need for external isolators.

Built-in suction and discharge line mufflers inside the unit results in quieter operation.

Motor winding heat is reduced by all suction gas passing directly through the rotor and stator windings, the company states.

An oil pressure regulator maintains constant oil pressure regardless of operating conditions.

A sight glass for checking oil pump operation.

Trane anticipates, by March 1961, installation of the Model D compressor in all its package equipment requiring 5 and 7½ hp refrigeration units. This includes its self-contained Climate Changers for commercial applications, and Climate Changer condensing units for residential air conditioning use.

More Information? Circle Item 44 on Inquiry Card.

New Heat Pump Installs on Outside Wall of Building

An air-to-air heat pump, introduced by Air Conditioning Div., Westinghouse Electric Corp., Staunton, Va., attaches directly to the outside wall of a building, greatly reducing the time and cost of installation.

The company states that the wall-mounted heat pump—first of its kind—brings a "quiet, practical and economical" form of central air conditioning to the mass housing market. And, the new unit is reported to be equally suited to a variety of other applications, including offices, mobile homes, motels, apartments, stores, factories, and gas stations.

The report continues: "Field tests in Miami, Tampa, St. Petersburg, New Orleans, Phoenix, and Los Angeles have proven this heat pump's effectiveness. One contractor placed the cost of the unit plus installation at approximately $495 for a ranch style home of concrete block construction. For this home, the heat pump was mounted on an outer wall adjacent to a clothes closet. Ductwork carries the cooled (or heated) air to a drop ceiling in the center hall. The return duct was located at the bottom of the closet.

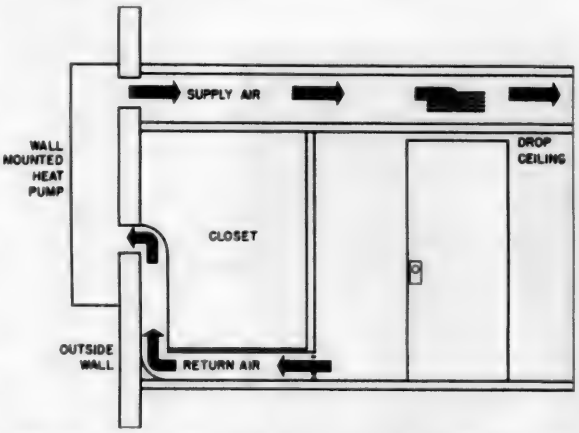


Diagram shows how heat pump can be mounted on the outside wall of a closet at the end of a hallway. Space above a drop ceiling extends the length of the hallway and serves as supply air duct. Normally wasted space at foot of closet serves as return air duct.

"The heat pump is rated at 18,000 Btu per hr which is equivalent to 1½ tons of cooling capacity. Each unit will serve a house with 1,000 square feet of area, but for larger homes two units may be applied, with one supplying the living-dining-kitchen area and the other the bedroom-bathroom area.

For servicing, this heat pump has a single aluminum back panel which can be removed. All moving parts are accessible from outside the house, as demonstrated here by Joseph Corny, residential products manager.

"The heat pumps may also be used in multi-storied dwellings with one unit serving each floor level. Installation is possible from a balcony, porch or garage roof. One unique method is to mount the heat pump on a hinged panel similar to a door, which is kept closed and locked when the unit is in operation. Opening the door into the room permits installation and maintenance.

"Approximately six feet high, two feet wide and one foot deep, the cabinet of the heat pump projects about the same distance from a wall as the overhang of the average roof. Brackets which are a part of the unit support it.

"For a home of block construction, only two blocks need be removed for installation purposes. Air flows into the home through the upper opening with a minimum of ductwork required, and returns to the unit through the lower opening. A similar installation can be made with wood frame, brick veneer or other forms of construction."

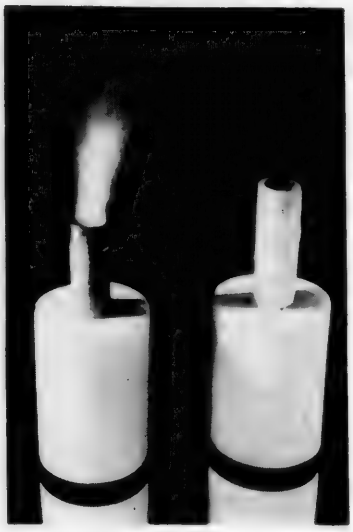
Built into the unit is a thermostat that the tenant or owner adjusts by reaching just inside the "return" opening. When more than one heat pump is used, individual thermostats provide zone control of air conditioning in the separate areas.

Unit is equipped with twin squirrel-cage blowers, driven by a ⅛ horsepower motor and capable of moving 650 cubic feet of air per minute through the ductwork. The back panel is removable, exposing all of the components inside. The embossed aluminum cabinet never requires painting.

More Information? Circle Item 41 on Inquiry Card.

Two Insulating Foams Developed

Two developments in insulating plastic foams were announced by The Dow Chemical Co., Midland, Mich. They are:



(1) Rigid urethane foam boards with high solvent resistance and heat distortion and low thermal conductivity. (Permanent *K* factor is 0.16 to 0.17 at 70 deg F.) Trademarked Thurane, the foam will be priced approximately 20% higher than Styrofoam on an equivalent insulation basis and 90% higher on equal thickness. The company expects significant applications in refrigeration appliances, pipe and refrigerator truck insulation, roof insulation, and sandwich panel and low temperature space insulation.

2. A blue Styrofoam brand insulation board with flame-retardant properties and designed to replace other forms of Styrofoam in major construction applications. The company states that it will be "competitively priced." Developed after three years of research, the product will replace Styrofoam 33, the previous flame-retardant polystyrene foam introduced in 1952. It is also expected to replace Styrofoam 22 in the construction industry.

Development and manufacture of rigid urethane foam board stock is considered by the company to be a highly significant addition to its line of plastic foams. As to applications of Thurane, the company states that because of its low thermal conductivity, high heat distortion and excellent solvent resistance, the material offers a wide range of possible applications. It has a unicellular structure, which is necessary for resistance to water penetration and water vapor transmission. Permanent low thermal conductivity permits the designer and manufacturer to use thinner sections of this foam to provide the same thermal insulation as a greater thickness of conventional insulation. This space saving feature is especially advantageous in insulation of trucks, railway cars, freezers, ships, homes and appliances.

Styrofoam brand insulation board is expected to find major use in comfort and low temperature insulation applications. It is self-extinguishing by ASTM D1692-59T. It is colored blue. The company will use the blue flame-retardant foam in Scorbord, previously sold as a black foam perimeter insulation board, pre-scored for ease of application.

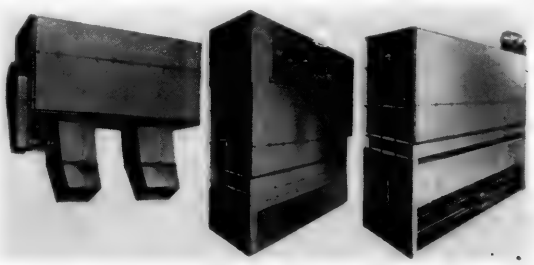
Because of improved properties, it is expected that Styrofoam insulation board will replace Styrofoam 22 in most construction applications, and in all cases, Styrofoam 33, the company's previous flame-retardant polystyrene foam, which was sold at a slight premium.

More Information? Circle Item 45 on Inquiry Card.

Expands Heating-Ventilating Line

An expanded Torrivent line for heating and ventilating large areas, such as school auditoriums, gymnasiums, commercial and industrial buildings, is announced by The Trane Co., La Crosse, Wis. The line now includes 102 standard units.

Expansion of 17 basic sizes with heating capacities from 20,000 to 3,800,000 Btu and air capacities from 600 to 54,000 cfm, has made it the largest line of its



kind in the industry, the manufacturer says. Six models, horizontal ceiling, horizontal floor, vertical floor, vertical wall, inverted ceiling and inverted wall permit adaptation to a greater number of installation sites throughout the building.

Sectional construction makes possible a step-by-step selection procedure of: (1) casing and fan section, (2) steam or hot water coils and, (3) accessories—filters, face and bypass dampers, mixing boxes, nozzles, discharge and return air plenums, wall intake boxes, humidifiers and vibration isolators.

More Information? Circle Item 46 on Inquiry Card.

Copper-to-Copper Globe Valve

A copper-to-copper globe valve, rated for 125 lb working steam pressure, 200 lb water, oil or gas, has been developed by Hammond Valve Corp., Hammond, Ind. to meet the increasing requirements of copper tubing for domestic and commercial construction. The valve, No. 424, has a screw-over-bonnet and swivel-type disc holder with composition disc for hot and cold water. It is interchangeable with a steam disc. Available in sizes ⅜ through 2 inches.

More Information? Circle Item 47 on Inquiry Card.

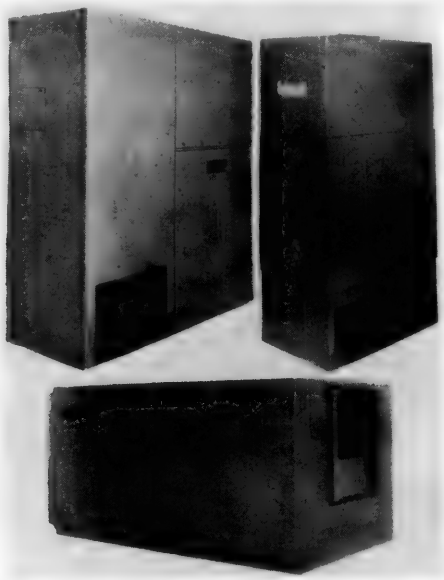
Expands Gas Absorption Line

An expanded range of unit capacities and a major absorption design breakthrough are expected nearly to quadruple the gas industry's air conditioning "market eligibility" during the next year, Arkla Air Conditioning Corp., Little Rock, Ark., states. While gas possessed unit capacities and designs to compete in only about 20% of the total central-system market in 1960, it anticipates being able to compete for about 80% of the market by a year or so from now.

Units planned for introduction during the next year include: Model 650, 4.3-ton; Model 750C, 5-ton remote; and Model 850 6.4-ton (illustrated top, left). All are All-Year cooling and heating units. The Model 650 will be in production soon; the 750C and 850 are expected to be available by fall.

Also included are Model 500C 3½-ton All-Year remote (for outdoor installation); Arkla Model DF-3000 direct-fired absorption water chiller-heater; a new vertically-installed 3½-ton capacity fan-coil-filter assembly (illustrated top, right), Model FCF 42-96V, to be available in upflow and downflow versions, as well as a horizontal model; and Arkla-Humphrey multi-directional gas unit heaters.

An Arkla 1¾-ton fan-coil-filter unit, the FCF 21-48, which will make possible zoning of residential



and small commercial applications, also will be available soon.

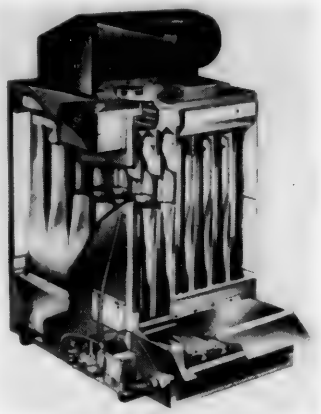
The company furthermore plans manufacture of a Model 650C 4.3-ton remote, a Model 655C 4.3-ton remote add-on cooling unit, and a Model D750 (downflow) five-ton. The Model D500, a downflow 3½-ton, just recently went into production at the concern's Evansville, Ind., plant. Development of gas equipment in the 2-ton range also is under way at Arkla, with introduction tentatively expected next year.

A growing line of fan-coil-filter units for use with its remote chilled-hot water gas air conditioning systems will soon be joined by the new Model FCF 21-48 air handling unit, also illustrated. The 1¾-ton cooling capacity FCF assembly will permit zoning of residential and small commercial air conditioning applications.

More Information? Circle Item 48 on Inquiry Card.

Horizontal Gas Duct Heaters

Extremely compact design of the horizontal gas duct heaters offered by Lennox Industries, Inc., Marshalltown, Iowa, permits their grouping for large heating requirements in an unusually small amount of space, the company states.



Among the major features listed by the company are: Dual limit controls to permit air flow in either direction; ability of units to be grouped downstream from a single blower with a multi-zone output, each with its own 24-volt thermostatic control; streamlined clam shell heat exchanger which offers low air resistance and maximum heat transfer; aluminized steel heat exchanger; ribbon type aluminized steel burners; 100% shut-off safety pilot; short, reversible diverter which permits installations close to ceilings; and heavy-gage steel cabinet.

Typical installations would be:

(1) Single duct heater with packaged blower for small heating requirements. Units suspended from ceiling, mounted in roof trusses, or installed in attic.

(2) Single duct heater with packaged blower and cooling coil for small all-season installation. Condensing unit installed on roof.

(3) Large, single zone system using ganged duct heaters, large cooling coil, and central blower package. Entire system can be ceiling or attic installed.

(4) Large system with central blower in equipment room serving several zones, each with its own duct heater and individual control.

(5) Large, multi-zone application using ganged duct heaters, individual cooling coils, central blower package, and ganged fresh air mixing dampers upstream from the blower.

More Information? Circle Item 49 on Inquiry Card.

Split-Eyelet Connectors

In installations requiring fittings for 1¼, 1½ and 2-inch piping or equivalent size tubing, No. 8370 split-eyelet connectors offered by Spraying Systems Co., Bellwood, Ill., can frequently offer considerable savings in overall cost, the company states. Because they are easily and quickly installed to continuing or un-cut pipe or tube lengths, installation time and fitting costs are significantly reduced.

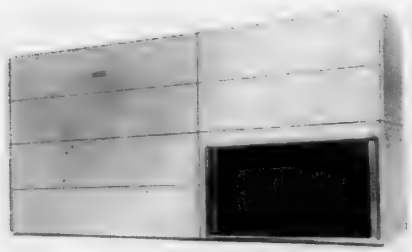
Connectors are used in place of reducer tees, and to connect such parts as spray nozzles, gages, and hose nozzles. The split-clamp is made of cadmium

plated, heavy-gage steel or of stainless steel. Bodies provide a ½-inch NPT female outlet and are made in choice of brass and stainless steel. Connectors are mounted simply by drilling a 11/16-inch diameter hole in the pipe or tubing and placing the connector in position. Twin-bolt compression of the clamp in combination with a special Buna-N gasket provides a leak-proof seal.

Connectors may be used for liquids and gases up to pressures of 150 psi. Use of the connectors eliminates need of cutting, threading and brazing operations at connection points and materially reduces the need for such fittings as tees and unions.

More Information? Circle Item 50 on Inquiry Card.

Air-Cooled Central Unit



A compact central station, air-cooled air conditioner with integral condenser, in capacities from 30 to 60 tons, is introduced by U. S. Air Conditioning Corp., Delaware, Ohio.

Initial model in a series of a full line, the 30-ton RK-30AC unit, for comfort cooling in industrial and commercial applications, combines all the elements of the company's RK series with the new air-cooled condenser. The company has been field-testing the new "RK-AC" series since 1957.

Features include dual circuit semi-hermetic compressors which operate individually or, automatically, together for full capacity; horizontally split evaporator coil which is effective where load variations require 50% capacity control or where dehumidification is needed at reduced operating capacity. An optional built-in modulating head pressure control is available for low outside air conditions. If desired, the unit can be furnished in two sections for remote location of the condenser.

More Information? Circle Item 51 on Inquiry Card.

Prefabricated Air Duct

A prefabricated air duct molded from fine glass fibers and encased with an air-tight vapor barrier is added to the line of insulations manufactured by Armstrong Cork Co., Lancaster, Pa. for air conditioning and heating systems.

The new material, called Armaglas Duct, is an air duct, thermal insulation and sound absorber in one piece. It not only has high insulation value but also greatly reduces application time, according to the manufacturer.

The air duct is manufactured to the same inside diameters as standard galvanized sheet metal furnace pipe. It is furnished in six-foot sections, ready for installation with standard galvanized sheet metal fittings, air boots, register boxes and other fittings that are regularly used in the installation of round sheet metal ducts.

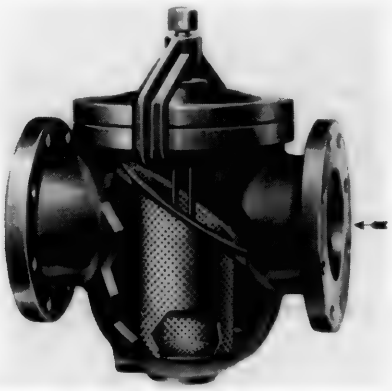
It is reported to provide an ideal system for heating now and air conditioning later. When air conditioning is added to the furnace unit, ducts need not be insulated and vapor sealed.

More Information? Circle Item 52 on Inquiry Card.

Basket Strainers

Four basket strainers for protecting pumps, valves and regulators are added to the line of strainers manufactured by Strong, Conneaut, Ohio, a division of White Sewing Machine Corporation.

Widely used in steam, air, oil, gas and chemical lines for catching dirt, foreign matter and pipe cut-



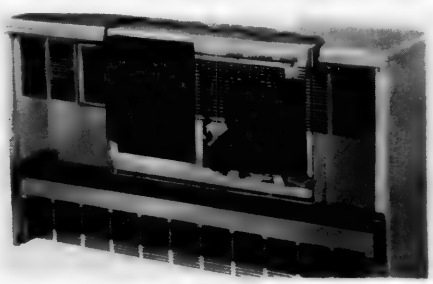
tings, basket strainers are recommended for most suction and high or low pressure installations. They are highly effective hair and lint catchers in swimming pool pump-and-filter installations.

Strainers, in semi-steel and cast steel, have clamped or bolted covers. Clamped covers are suitable for most applications and facilitate strainer cleaning. Bolted covers are supplied for applications subjected to pressures up to 600 psi at 800 deg F. Sizes range from 2 to 16 inches with flanging from 125 to 300 lb. Baskets are brass or stainless steel with 3/32-inch perforations.

More Information? Circle Item 53 on Inquiry Card.

Convector-Conditioner Units

Vectormatic combination convector radiators and through-wall air conditioners are introduced by Fedders Corp., Maspeth, N.Y. Both heating and cooling units are combined in a compact cabinet that fits



under standard windows and projects only 8 inches into the room. According to the company, this arrangement will provide maximum performance at minimum cost.

Seventeen Wall-Fit chassis, with cooling capacities from 6,000 to 13,500 Btuh, are available. Heating element has aluminum fins with die-formed collars bonded completely to internally expanded ½-inch copper tubing. Convector cabinet and through-wall sleeve may be installed at one time, the cooling chassis at another time.

The company also announced six new 5-hp Adaptomatic central air conditioners. Over 25 separate models include straight cooling units, heat pump units, and models with supplementary electric resistance or gas duct furnace heating. Models are also available in 2- and 3-ton sizes. Adaptomatics are designed for whole-house air conditioning, for small and large stores and offices, and for large commercial buildings, the company states. Split chassis design is responsible for the adaptability. Blower system and complete hermetic refrigeration system are contained in two separate cabinets which fasten together, in minutes, with a few bolts and plug-in electrical connections.

More Information? Circle Item 54 on Inquiry Card.

Compact Calculator

Type 2 lightweight calculating machine, introduced by Curta Co., Van Nuys, Calif., is said to combine accuracy, speed and versatility of a large desk calculator with the portability of a pocket slide rule for every type of mathematical operation. It has a capacity of 11 digits on the keyboard, 8 digits on the indicator dial and 15 digits (corresponding to 999 trillion) in the answer dial.

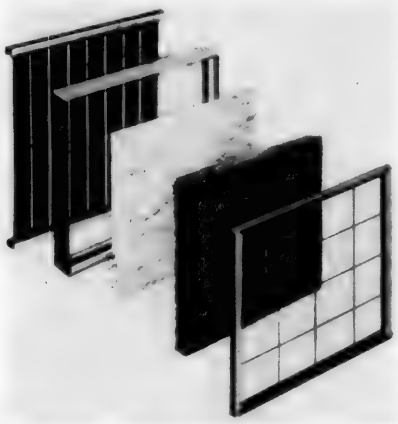
Precision made of stainless steel and high grade anodized aluminum alloys, the cylindrically shaped machine is about the size of a fishing reel and weighs 12 ounces. Easily held and operated in one hand, it requires no external power supply. A continuous tens transfer and reversing lever permits short-cut techniques in the basic operations of multiplication, division, addition, subtraction and in multiple operations involving cubes, roots, percentiles and trigonometric functions. Automatic stops prevent errors in operation or damage from overspeeding in fast operation.

Calculator is supplied in an attractive dust and shockproof metal container and is guaranteed for one year.

More Information? Circle Item 55 on Inquiry Card.

Replaceable Filter-Adsorber

Roto Aire combination replaceable media air filters and activated charcoal air purifiers offer an effective combination for cleaning and purifying air in new and existing systems, according to manufacturer, Burke & Co., Los Angeles, Calif.



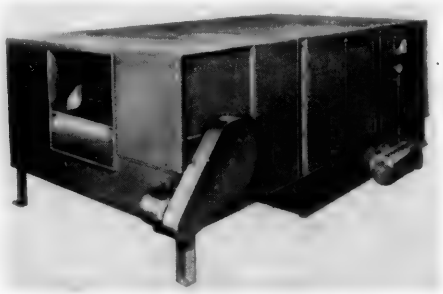
Both air filter and adsorber sections are contained in a single case, especially developed for the slide-in type filter section of any standard air handling unit designed to accommodate a 2-inch air filter. Units are flexible in that they may be operated at varying velocities. Filter section may be packed with varying densities and combinations of media.

Adsorber section is comprised of a series of replaceable cartridges containing activated charcoal.

More Information? Circle Item 56 on Inquiry Card.

Sprayed Coil Air Handlers

A sprayed coil draw-thru Climate Changer, engineered to reduce installation time and simplify maintenance, is announced by The Trane Co., La Crosse, Wis. Available in 14 horizontal and 13 vertical sizes, it features internal factory insulation of the entire unit, including the tank section. Thus, the requirement for on-the-job tank insulating is eliminated.



Spray pump and piping, including gate valve and pressure gage, are also factory mounted to save installation time.

Wide angle, 3/8-inch diameter spray nozzle orifices are virtually clog-proof, the company states, but for areas where water may have a high fouling factor, nozzles are easily removable.

Spray action, float operation and the condition of the coils may be checked through unbreakable windows on both sides of the unit. Access is gained through strategically located, removable panels.

Sprayed coil units are used where a high percentage of outside air is needed for ventilation, such as hospitals, special industrial processes and in the primary air circuit of induction systems. Advantages include cleaner air; the optional use of more accurate and economical dry bulb control; and air conditioning by evaporative cooling when refrigeration is turned off during "in between" seasons.

More Information? Circle Item 57 on Inquiry Card.

Improved Sealer Dispenser

An improved snap-action, clean cutting, positive-feed dispenser for Thred-Tape pipe joint sealer is announced by Crane Packing Co., Morton Grove, Ill. It provides a simple, convenient and dirt proof device for handling the tape.

Dispenser consists of a transparent plastic case upon which the chrome-plated cutting and dispensing mechanism is mounted. The amount of tape still available is always visible. A knurled cylinder, conveniently mounted for thumb operation, feeds the

tape through the cutter. When the desired amount of tape is exposed, light thumb pressure on the feed cylinder actuates a steel cutter with a ground and tempered knife edge to cut off the tape. Entire operation is performed with one hand, leaving the other free to wrap the tape around the pipe threads as it is being dispensed.

Sealer is effective under the most difficult service conditions, including practically all corrosive chemicals, caustics, hydraulic and aromatic fuels, also toxics, biologicals and gases. Temperature range is from −250 to +500 deg F, pressures to thousands of pounds. Application is extremely simple: tape is cut to length and wrapped around the threads.

More Information? Circle Item 58 on Inquiry Card.

Gas Burners

Wayne Home Equipment Co., Inc., Fort Wayne, Ind., is introducing a line of gas burners to satisfy 90% of today's market requirements, it states. Input ranges of the line are as follows: domestic power burners 400,000; atmospheric inshot burners to 225,000; commercial power burners to 1,000,000; and atmospheric upshot conversion burners to 275,000 Btu.

Conventional in design, with approved controls, and listed by AGA, these burners were developed for manufacturers of heating equipment as original equipment components, and through trade channels for unit sales to end users.

More Information? Circle Item 59 on Inquiry Card.

Just Dial Cleaner Air

A new concept in electronic air cleaning for homes or small commercial establishments—a unit that is adaptable to a broad capacity range of central heating or cooling systems by simply turning a dial—is introduced by Trion, Inc., McKees Rocks, Pa.

Called the Model UMT (Utility Model Trion), it offers a versatility not heretofore available in one

unit. This is achieved through use of a Capacity Selector, enabling this one unit to be used with heating systems ranging from 80,000 to 200,000 Btu per hr capacity, or cooling systems of 2 to 5-ton capacity. The adjustment is accomplished by simply dialing the desired capacity on the Capacity Selector located on the power pack.

With an efficiency rating of 95% (N.B.S. Dust-Spot Test), the Trion UMT is priced at approximately one half the cost of comparable deluxe electronic air cleaning equipment, according to the manufacturer. Like the more expensive electronic air cleaners, it has a built-in washer which is activated by simply turning a valve. There is no need to remove cells for cleaning; there are no filters to remove for cleaning or replacement.

More Information? Circle Item 60 on Inquiry Card.

Make-Up Air Unit

Model VR-2 Sun-Flo one-piece make-up air unit, which mounts on roofs of commercial and industrial buildings, is offered by Metals Engineering & Mfg. Co., Detroit, Mich. It is direct gas fired and automatic.

These compact, vertical units are made in nine sizes in capacities from 20,000 to 60,000 cfm and from 1,875,000 to 6,000,000 Btuh. According to the manufacturer, they utilize a minimum of roof space for their rated capacity, with air intake through louvers mounted atop the unit. Filter banks are optional equipment, with filters serviced through access doors from a platform (also optional).

Automatic controls, mounted inside, are accessible through a walk-in door. Automatic shut-down dampers are standard. A remote control station is available with *start* and *stop* buttons and summer-winter selector switch. All units are equipped with Maxon's Series H burner and mixer.

More Information? Circle Item 61 on Inquiry Card.

Apartment-House Package

A packaged hot water system for apartment houses and motels, offered by Raypack Co., Inc., El Monte, Calif., furnishes domestic hot water, hot water for hydronic central heating, and swimming pool water heating. Equipment in the one-package system consists of a boiler, hot water storage tank, a copper immersion heater coil for the storage tank, and a separate indirect swimming pool water heater. Also included are accessories, as pumps, expansion tank, and controls.

According to the manufacturer, the package approach to apartment house plumbing and heating results in a lower initial cost for equipment and, more economical installation (only one vent, gas, and water line needed).

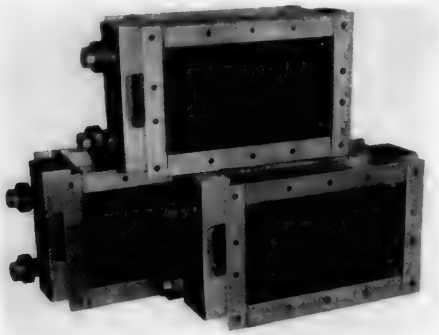
System employs the company's indirect heating principle, in which raw water from the city main flows into a storage tank containing a copper-coil heat exchanger connected to the boiler. Water in the heat exchanger is never changed, being continually recirculated between boiler and exchanger. Hence, liming of boiler never occurs.

More Information? Circle Item 62 on Inquiry Card.

Maritime Coils

Ruggedly built maritime coils for preheat, reheat and cooling have been added to the line of heating and cooling coils of Danville (Illinois) Div., Bohn Aluminum & Brass Corp., Danville, Ill.

In addition to meeting or exceeding maritime specifications, the coils are tested and rated according to ASHRAE standard 33-58. They feature 4 to 8 die-



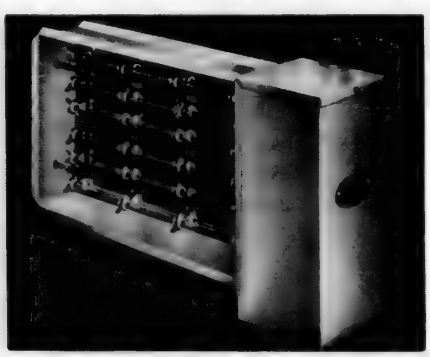
formed plate-type copper fins per inch with self-spacing collars completely covering the tubes. A permanent, tight metal-to-metal bond is achieved by mechanically expanding the tubes into the fin collars.

Casings are heavy-gauge die-formed, galvanized steel with four flanged sides. Headers are of heavy-wall seamless copper tubing with heavy die-formed end caps. Coils are pressure tested at 400 psig.

More Information? Circle Item 63 on Inquiry Card.

Universal Duct Heaters

The EDT1 electric duct heater offered by Lennox Industries, Inc., Marshalltown, Iowa, handles 5.7 kw for an output of 19,500 Btuh. These can be installed, as many as needed in parallel in one duct, or in series



in one duct, regardless of direction of air travel. This unit has its own low-voltage transformer for activating the thermostat, and has capacity to activate the relays in three additional "slave" units. Time-delay switching is also available to bring the units on and off the line at 20-second intervals to eliminate line surge and sag.

More Information? Circle Item 64 on Inquiry Card.

New Baseboard Damper

Unlimited variations in the control of heat flow are possible with a new damper designed by American-Standard Plumbing and Heating Div., New York, N. Y., for its Model L Heatrim baseboards.

Where formerly conventional dampers could be set at a fixed number of positions to vary heat flow, the new design features a graduated opening with unlimited settings possible between the open and closed position. Heat flow can therefore be set to meet the requirements of an installation exactly. At the same time, the damper blade flange gives permanent alignment and a sturdy, steady fit, the company states.

Installation of the damper is simple with its "snap-in" design. A friction plate is inserted in the bracket punch-out, and the damper blade snapped into place under the plate. The damper is available as optional equipment on all Model L Heatrim baseboard panels.

More Information? Circle Item 65 on Inquiry Card.

Supplies, Exhausts at Same Time

Called an innovation in air handling, the Twinalator air handler, offered by Clarage Fan Co., Kalamazoo, Mich., is a single-impeller package unit which provides both supply and exhaust simultaneously.

According to the manufacturer, the dual-function unit is suited to a wide variety of applications in all types of buildings. It replaces the double installation of exhaust fan operating in conjunction with a supply fan or make-up air unit.

Advantages are said to include the following: Only one opening is necessary. Only one motor, drive and starter are involved, substantially reducing first and maintenance costs. Installation time is cut in half. Fresh air is drawn from above the roof levels, where the atmosphere is cleaner than at lower levels. By providing a proper balance between supply and exhaust, drafty leaks around windows and doors are reduced to a minimum.

Fresh air supply, delivered under pressure, can be directed to adjustable louvers at the unit or ducted to specific areas. Exhaust air can be taken from under the roof or ceiling for general ventilation, or it can be ducted a reasonable distance from specific sources to prevent contamination of the over-all area.

For Industrial Ventilation, Too

The Twinalator is well adapted to industrial ventilation. It is applicable for temperatures to 200 deg F and for gases and fumes. Unit is suited to closed or semi-closed systems, such as laboratory hoods, commercial laundry machines, industrial metal cleaning, or any installation where supply and exhaust may be ducted in the immediate area of contamination.

More Information? Circle Item 66 on Inquiry Card.

Pre-Insulated Copper Pipe Developed; Manufacturers Wanted

Pre-insulated copper pipe and tube, made by extruding a foamed plastic around copper tube has been developed by Quantum Inc., Wallingford, Conn., a research laboratory, in cooperation with Copper Products Development Association, 25 Broadway, Rm. 1810, New York 4, N. Y.

The insulated tube can be handled in the same way as ordinary copper pipe, with the exception that the plumber would cut and strip the insulation when he makes a joint and then cover the bared area with the proper coupling, elbow, or tee insulation fitting.

The only extra labor in installing a completely insulated system is the slight effort needed to strip for soldered joints and to paste the split-half insulation fittings to the pipe—only a few minutes of time on the average house plumbing job.

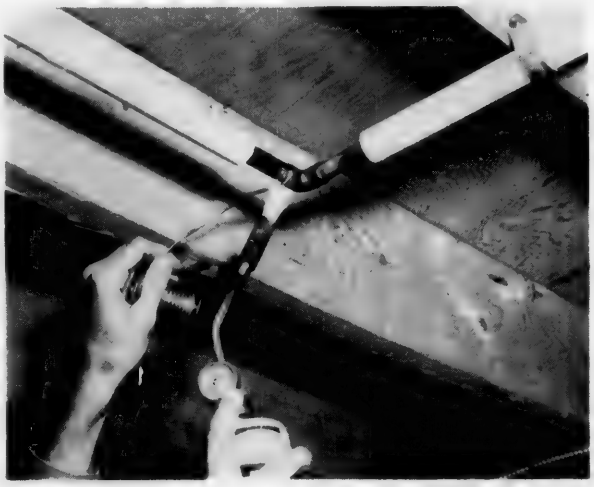
Aside from the savings in labor, the pre-insulated pipe will greatly reduce material cost, the Association states. A ¼ inch coating of inexpensive foamed urethane plastic provides the insulating value of one inch of cork, or one and one-half inch of magnesia insulation. This high insulation value enables the use of insulated pipes of small cross section that are unobtrusive where exposed and that can readily be passed through 2 x 4 inch partition walls.

According to Dr. Charles H. Moore, technical director of the Copper Products Development Association, it is contemplated that merchandisers of pre-insulated copper tubing would extrude the foamed insulation onto the pipe at warehousing centers, since relatively simple equipment is needed for the process. This would eliminate extra space requirements in long-distance shipping. However, he stated, the experimental insulated pipe produced to date has proved to be shatter-proof under ordinary handling and could readily be shipped cross-country.

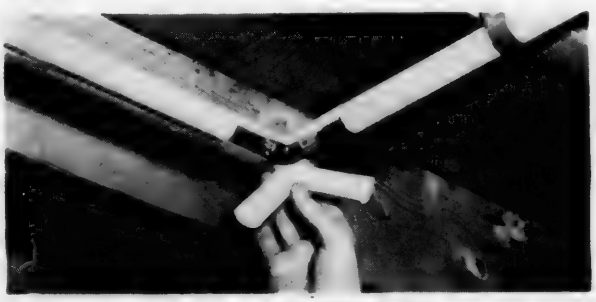
Major uses for insulated copper pipe are foreseen in home heating systems, either steam or hot water; in cold water systems to prevent condensate and pipe drip; in refrigeration and air conditioning piping; in industrial piping applications; and in institutional heating and cooling. It is believed that pre-insulated pipe will be especially attractive for use in the basement water lines of homes, where the drip problem has been troublesome in recreation rooms, laundries, and service areas.

Dr. C. M. Doede, president of Quantum, Inc., states that a typical foamed urethane pipe insulation is 95% lighter than present competitive materials, requires 75% less installation space, and has temperature stability up to 300 deg F. The formulation used results in a semi-rigid material that has a smooth outer skin. It can be produced in any color —suggesting the possibility of "decorator" colors for exposed installations in homes, offices, or institutions. An additional advantage of the material is its ability to dampen pipe "hammer" under water or steam flow, and special acoustical formulations could be manufactured for use where noise reduction is a prime aim.

Pre-insulated copper pipe would come to builder in the usual lengths, with ends bare.



After installation, joints would be soldered in the usual manner. Foamed plastic insulation is stable up to 300 deg F. Should it be accidently ignited by torch, it is self-extinguishing with removal of flame.



On completion of joint, molded split-half fitting is cut to length and put in place with an adhesive. All standard-joint insulation fittings would be available.

The insulation adheres tightly to copper pipe, yet when an end is to be stripped for soldering, a circular cut and a twist of the wrist removes the unwanted piece. The split-half coverings for various types of joints are premolded and are applied with an adhesive.

The Copper Products Development Association provided funds for determining the engineering properties of the pre-insulated pipe and is assisting Quantum, Inc., in locating manufacturing outlets for the development.

MAID-O'-MIST Inc.
HEATING SPECIALTIES

automatic

AUTO-VENTS®

NO. 7 SERIES

vent air out of hydronic hot water heating and chilled water cooling systems

. . . and vent it

continuously!

for VERTICAL MOUNTING

on

- Pipe Lines
- Mains - Coils
- Unit Heaters
- Chillers
- Convectors
- Radiant panels

75 to 150 lbs. pressure
4⅜" x 2¼"

All hydronic hot water heating and chilled water cooling systems collect air in pockets and stop the water from flowing freely. These inexpensive, easy-to-install Auto-Vents get the air out and keep it out because they work automatically with a *float operated valve*. There are four of these efficient trouble-shooters in the #7 series, with male and female connections. Learn more about them!

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3217 North Pulaski Road Chicago 41, Illinois

For more data circle this page number on card at back of book

Roof-Top Package

A completely self-contained roof-top cooling unit, and a combined heating and cooling unit for offices, stores, and other single level commercial buildings have been developed by Curtis Manufacturing Co., St. Louis, Mo.

The cooling system is available as a separate unit while the year-round temperature control system is a three-part package consisting of an air-cooled condenser unit, a cooling section, and a gas-fired unit for heating. Models are available in 7½ and 10 ton sizes.

The roof-top system requires only one opening through the roof for combination supply and return air duct. No other ductwork or refrigeration piping is required. With roof-top location, valuable floor area is gained.

Packaged unit is enclosed in a weatherproof housing of heavy-gage embossed aluminum sheet.

Circle Item 67 on Inquiry Card.

Air-Particle Monitor

By the addition of an air-dilution system to its Model PC200A airborne-particle monitor, Royco Instruments Inc., Palo Alto, Calif., provides an instrument capable of accurately describing the spectrum of particles present in specimens of air ranging from clean-room atmospheres to the most polluted industrial smogs. In addition, the dilution system, available by itself, can be used in the laboratory to give an accurate means of mixing air or gases in controllable proportions.

Used with the monitor, the new dilution system mounts in a standard 19-inch rack or in a metal cabinet, the individual panel being 7 by 19 inches. The dilution system provides a continuously variable addition of filtered dilution air from 0 to 200 cc per minute to a basic sample, giving dilution ratios from zero to 50:1. Its design is such that it can be cut in or out instantaneously, making the airborne-particle monitor very flexible in use.

Circle Item 68 on Inquiry Card.

Pipe-Viewing Camera

A closed-circuit television camera, designed to explore pipes as small as four inches in diameter, is a development of GPL Div., General Precision, Inc., Pleasantville, N. Y. Watertight to a depth of 10 feet and 5 psi pressure, it has a built-in light source of 30 ft-candles at one foot, and a removable rotating mirror for axial or radial viewing.

The prototype of this camera has long been in use by a major eastern utility company, and it has been found well-suited for the following: to locate unmapped connections; to inspect pipes for corrosion holes; to examine valves to determine if they are partially open or closed; to determine if there is liquid in a main; to locate obstructions in the pipe; and to inspect sealing operations on cast iron mains.

Circle Item 69 on Inquiry Card.

Air-Handling Troffers

A completely new concept in air-handling troffers, called Triple-Shell Lumi-Flo, is announced by Benjamin Div., Thomas Industries Inc., Louisville, Ky., and Tuttle & Bailey, division of Allied Thermal Corporation, New Britain, Conn.

These units provide light, cool air or warm air from a single concealed ceiling fixture, and are reported to be perfectly adapted for use in offices, institutions, stores, laboratories, schools, hotels, and restaurants—to almost any type of building, old or new, with any type drop ceiling.

One of the most important features of this line of equipment is that the air passageway is completely isolated from the troffer housing by fiberglas insulation and an insulating air gap, thus removing the possibility of temperature variations affecting the light output of the unit.

In addition, the air-handling capacity of these units has been almost doubled over currently available products, the companies state.

Circle Item 70 on Inquiry Card.

MAID-O'-MIST Inc.
HEATING SPECIALTIES
automatic

AUTO-VENTS®

NO. 27 and 37

No. 27 is 3" x 2½", ⅛" I.P. Female side connection

for

HORIZONTAL MOUNTING

on

- Combination heating & cooling convectors
- Fan coil units
- Radiant panels
- Radiators
- Pipe Lines

No. 37, 3" x 2½", ⅛" I.P. vertical male bottom connection

They vent air CONTINUOUSLY in hydronic hot water heating and chilled water cooling systems

FOR PRESSURES UP TO 50 LBS.

Simply designed, they do a most effective job of getting rid of air pockets, letting the water circulate freely, automatically, thanks to a reliable float valve. Learn more about these inconspicuous vents that cost so little,—yet do so much!

WRITE FOR CATALOG

MAID-O'-MIST, Inc.
3217 North Pulaski Road Chicago 41, Illinois

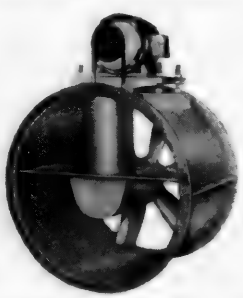
For more data circle this page number on card at back of book

DON'T
STEW
OVER
FUME
REMOVAL

Hartzell All-Fiberglass Duct Fans offer unsurpassed resistance to corrosion...

at a cost far below that of stainless steel or monel units

Hartzell fiberglass duct fans have lasted for years in installations where the fans previously used has required replacement after only a few months of service. Yet, despite this exceptional resistance to acids, alkalies and other corrosive elements, the cost of Hartzell fiberglass units is much closer to that of duct fans of conventional construction than it is to that of stainless steel or monel units which are often prohibitively expensive. Seven sizes, 12" to 44". Fiberglass stack cap also available.



For complete details, just give your nearby Hartzell field engineer a call. You'll find him listed in the Yellow Pages or in the Hartzell catalog in Sweet's Plant Engineering and Industrial Construction Files.

Hartzell PROPELLER FAN COMPANY
Division of Castle Hills Corp. • PIQUA, OHIO
A Member of AMCA

For more data circle this page number on card at back of book

Process Steam Traps

A completely new line of traps for process steam applications ranging from 15 to 150 psi is announced by Modine Manufacturing Co., Racine, Wis.

The newly designed float type Series M27 drip trap has a maximum pressure of 15 psi, but is available with thermostatic air by-pass, and also without the thermostatic element and air by-pass for use where manual venting or external air by-pass are specified. Also, where concentration of air does not occur, such as on ends of mains and risers, on flash tanks and for dripping gravity heating systems into vacuum return air lines.

Series M78 thermostatic traps have a maximum pressure of 150 psi and will provide automatic, quiet and complete discharge of air and condensate from process steam equipment. Available in the angle pattern only, this series has body and cover made of brass. The expansion part of the trap is made of Monel metal and is heavily ribbed. It is held securely in position in the trap body by means of a heavy-gage brass circular plate. An extra-thick shoulder keeps the upper part of the diaphragm far enough away from the plate to permit steam to entirely surround the diaphragm.

Series M80 float type drip traps are applicable in the process field where pressures range up to 150 psi. Available in three sizes with ¾, 1 and 1¼-inch connections, these traps are provided with interior mechanisms for five different pressure ranges.

A float-operated mechanism assures complete and continuous discharge of condensation. A thermostatic air by-pass keeps the trap and the unit to which it is attached completely free of air and non-condensable gases regardless of the quantity of condensation being handled. All drip traps have a stainless steel water valve and seat, and all operating parts are made of 18-8 stainless steel stampings.

Circle Item 71 on Inquiry Card.

When It Comes to Humidification . . .

Here is some information to consider:

The use of dry steam is very often the simplest way to humidify.

Advantages of Steam Humidification

1. Steam is ready-made vapor which merely has to be mixed with air in the duct system or discharged to the humidified area.

2. Steam is pure water vapor—no mineral dust as comes from evaporated water droplets.

3. Steam may be shut off immediately when control is satisfied.

4. Steam comes on immediately when control calls for humidity.

5. Duct system and air handling units are always dry. Thus, there is no odor, no growth of algae or bacteria, no corrosion problem.

Armstrong Steam Humidifiers are scientifically designed, automatically controlled steam valves for admitting steam vapor to the humidified area, either directly or into the air stream in ducts or plenums. The humidifiers dry the steam and muffle the noise of the discharge.

Thousands of Armstrong units are used successfully in industries working with hygroscopic materials, in offices, plants and institutions for improving health and comfort conditions and in offices, plants and institutions for control of static electricity. Every installation is backed by a sales and service network that blankets the United States and Canada.

Advantages of Armstrong Humidifiers

1—Low cost and large capacity.

2—Minimum maintenance, proved by thousands of installations.

3—Quiet operation.

4—No carry-over or drip.

5—Immediate response to control.

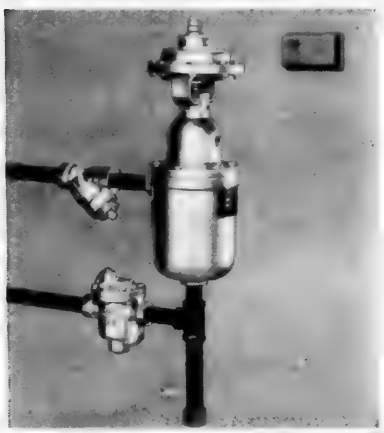
6—Low operating expense.

7—Guaranteed tabulated capacities.

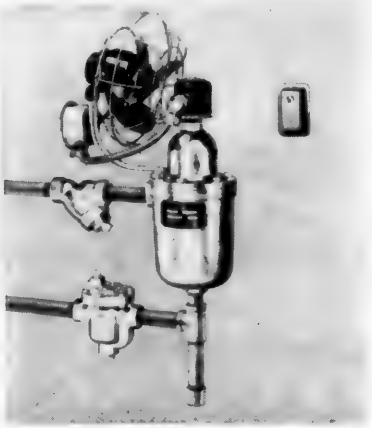
8—Selection is simple and easy.

9—Small space required makes duct design easy.

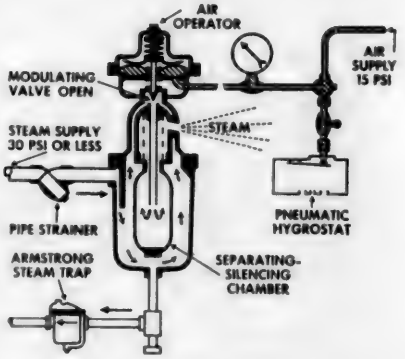
10—Easy installation.



AM-32 Air-Modulating Humidifier complete with strainer, trap and hygrostat. AM-33 similar.



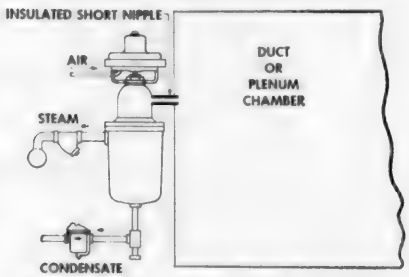
FCL-2 Humidifier complete with fan and motor, humidistat, fine mesh strainer and trap. FCL-3 similar.



HOW THEY WORK

Air-Operated Units—When relative humidity drops slightly below desired level, the pneumatic hygrostat increases air pressure in operator to open modulating valve in proportion to demand. When demand is satisfied air bleed closes the valve. Air-operated units usually discharge to ducts or are installed in plenums.

Electric Units—When relative humidity drops slightly below desired level, humidistat energizes solenoid to open steam valve and start fan. Steam flows through muffler to atmosphere and is dispersed by fan. When desired humidity is reached, humidistat closes valve and stops fan. Units with fans normally discharge to the atmosphere. Units without fans available for discharge to ducts.



Typical installation of Armstrong Humidifier discharging dry steam to ventilating air duct.

TYPICAL CAPACITIES

Capacities for representative steam pressures expressed in pounds of vapor per hour added to the atmosphere. Capacities for intermediate pressures will be furnished on request.

Steam Pressure	Model No.	Air Operated			Electrically Operated		
		AM-32	AM-33	DA-34	FCL-2 or DCL-2*	FCL-3 or DCL-3*	CK-4
	2	48	85	145	48	85	145
	5	84	149	350	84	149	340
	10	122	217	645	62	166	610
	15	154	272	900	78	209	810
	20	181	321	1080	62	181	980
	25	205	364	1230	70	205	1130
	30	229	407	1425	78	229	1280

*FCL models are equipped with fan. DCL models have no fan and are tapped for 1" connection to air duct.

For Complete Information

SIXTEEN-PAGE BULLETIN NO. 500 contains a wealth of information about humidification. Tells: how relative humidity affects products and profits . . . other effects of relative humidity . . . recommended humidities for various operations . . . advantages of Armstrong Steam Humidifiers . . . how present users have profited . . . complete data and prices on all Armstrong humidifiers . . . selection and installation data. To get your copy, just call your local Armstrong Representative or write

ARMSTRONG STEAM HUMIDIFIERS

ARMSTRONG MACHINE WORKS 8466 Maple Street—Three Rivers, Michigan

Manufacturers of Armstrong Inverted Bucket Steam Traps

SATISFACTION GUARANTEED

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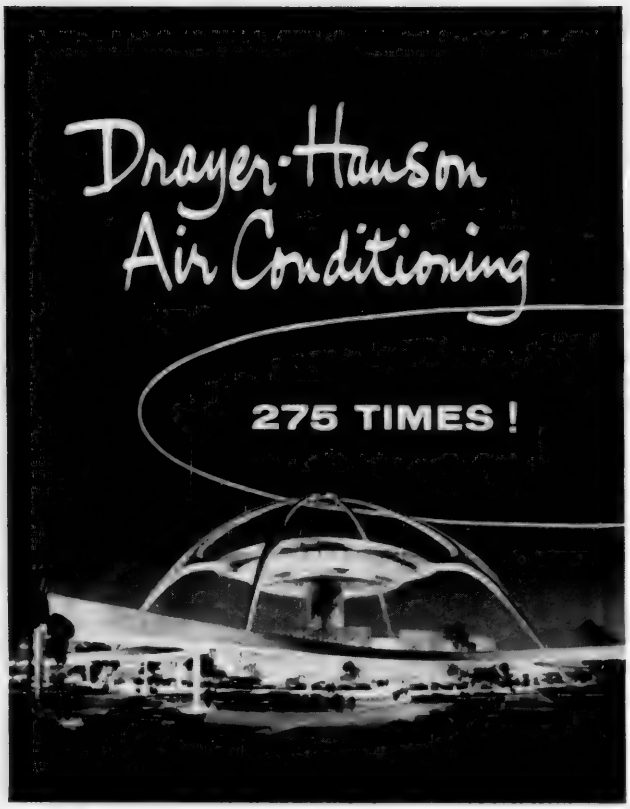

$50 Million Dollar

NEW TERMINAL AND AIRFIELD FACILITIES

Los Angeles International Airport

D-H's POPULAR "FZ"—"V"—"H"—"AM" and "HRC" UNITS!

NEW TERMINAL • TICKETING STRUCTURES • SATELLITE BOARDING

For Los Angeles Dept. of Airports—Joint Venture Architects and Engineers: Charles Luckman Associates, Welton Becket Associates, Paul R. Williams. General Contractor: Robert E. McKee. Mechanical Engineer: J. S. Hamel, Engineer. A/C Contractor: Climate Conditioning Co., Div. Paul Hardeman, Inc. D-H Sales Agent: Air Conditioning Supply Co.

These Brochures tell you why: HRC 211.01, CSHV 312.01, FZ 321.01 and EMG 5715.

drayer-hanson

DIVISION OF
HI-PRESS AIR CONDITIONING OF AMERICA, INC.
3301 Medford Street, Los Angeles 63, California
(Cable: Cliconi, Los Angeles)

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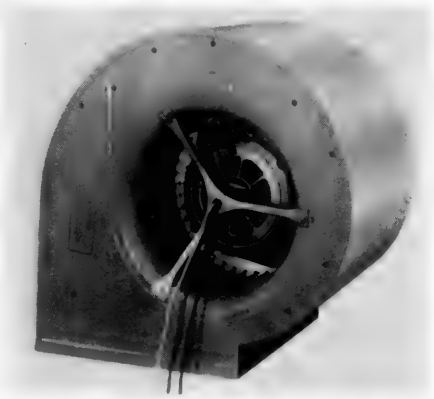
Reverses Rotor, Stator

An "inside-out" blower motor that reverses the conventional relationship of rotor and stator is announced by Electric Motors Div., A. O. Smith Corp., Tipp City, Ohio. In this unusual fractional horsepower design, the outer, stationary element—or stator—of a conventional electric motor becomes the rotor to which a blower wheel is attached. Field windings are placed in the shaft assembly, which



becomes the stator. The outer shell of the motor—rather than the inner assembly—thus spins to effect maximum efficiency of centrifugal blower action in minimum space.

The "inside-out" motor is of a permanent split capacitor type, thus affording increased efficiency and eliminating the conventional centrifugal switch or relay. It is a direct drive type of unit; hence pulleys, belts, and motor mounts are eliminated with a corresponding space-saving factor.

More Information? Circle Item 72 on Inquiry Card.

Plastic Pipe Compounds in Color

PVC plastic pipe compounds, hitherto supplied for one-speed drying of conventional gray-pipe color, are now available in colors to match needs of individual requirements. They also are available with drying speeds to meet the particular requirements of small or large section bonding, according to Schwartz Chemical Co., Inc., Long Island City, N. Y.

Availability of colors to match pipe, and drying speeds to match pipe size customize the cement for the job, according to the firm. Slower drying speeds make it easier to bond large sizes of pipe; the faster or standard drying speed saves time when smaller pipes are joined.

The company stresses the fact that these two new features, available on specification, do not impair the physical properties of the pipe bond. They are described as improvements in a product that has hitherto served a strictly functional purpose, without special economic or esthetic advantages.

More Information? Circle Item 73 on Inquiry Card.

Alnor Instruments...for quick, precise, measurement of air flow—surface temperatures

Alnor VELOMETER®

a sensitive instrument that will give instant direct reading of air flow in feet per minute. Readings as low as 20 f.p.m. can be made. The triple graduated scale on the dial can register a high of up to 24,000 f.p.m. or 20 in. of water.

The Velometer will give direct reading of static pressure in ducts, plenum chambers, or pipes. Register pressure loss across heater and filters, friction loss at ells and deflectors. Many government and municipal jobs require Velometer checking before acceptance.

For general use in air conditioning, warm air heating and ventilating, Velometer set No. 3G is recommended. Consists of the Velometer with rugged reinforced carrying case, supply jets, return jets, static pressure jet, duct jet and diffuser jet. Price f.o.b. Chicago $194.00.

For quick, simple, checking on circulation in balancing duct outlets the small self-tained Velometer Jr. (4" x 3" x 1½") can be used, where the work does not require the use of jet attachments. Available in three double air flow ranges, 0-200 f.p.m. and 0-800 f.p.m., 0-400 f.p.m. and 0-1600 f.p.m., 0-500 f.p.m. and 0-2500 f.p.m. Price f.o.b. Chicago $44.00 Bulletin 2448 gives complete information on the Velometer and all attachments.

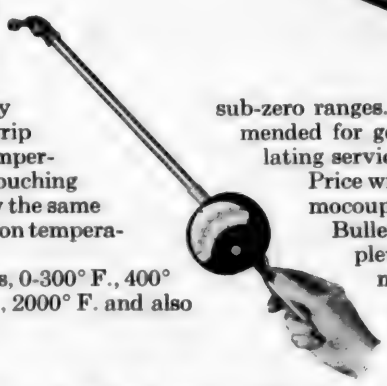
Alnor PYROMETER Model 2300B

Registers surface temperatures accurately and instantly by simply touching the thermocouple tip to any surface, or will register air temperatures at grills, inside ducts etc. with the air temperature thermocouple tip. Saves time with quick, positive readings. Can be used to set thermal expansion valve on cooling coils in less than a minute.

Balance hot water systems accurately. Test insulation and temperature of walls, floors and ceilings.

Locate hot water pipes in cement floors. Use it any place where surface temperature readings are required. Has full 6 inch mirrored scale. Temperature range —40° F. to 200° F. Complete unit in attractive durable case. Price from $195.00 f.o.b. Chicago.

Alnor PYROCON®



A compact hand held pyrometer with heavy-duty shock-resistant construction and with a firm grip handle balanced for easy handling. Accurate temperature readings are registered immediately on touching the tip to any surface. Can be used for practically the same service as the Alnor Pyrometer described above on temperatures within the range of the instrument.

Can be furnished in eight temperature ranges, 0-300° F., 400° F., 500° F., 600° F., 800° F., 1000° F., 1200° F., 2000° F. and also sub-zero ranges. The 0-300° F. is recommended for general heating and ventilating service.

Price with case and shielded thermocouple $125.00 f.o.b. Chicago. Bulletin No. 4257 gives complete information on Pyrocon models and accessories.

ALNOR INSTRUMENT CO.

Division of **Illinois Testing Laboratories, Inc.**

Room 570 • 420 North La Salle Street • Chicago 10, Illinois

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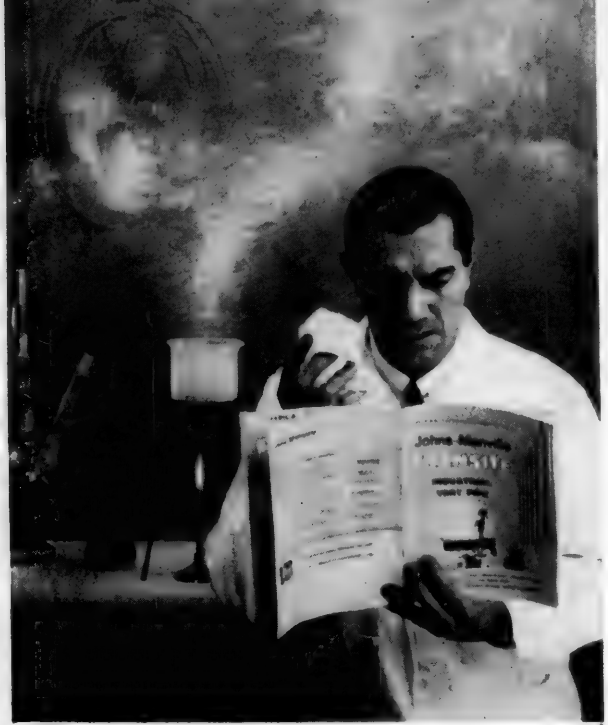
FREE BOOK TELLS HOW TRANSITE® PIPE SAFELY VENTS INDUSTRIAL GASES... CUTS COSTS

Send for your copy today!



JM JOHNS-MANVILLE

Box 14, AHV-2, New York 16, N. Y.
In Canada: Port Credit, Ontario

Please send me, without obligation, your facts and data book on Transite Industrial Vent Pipe.

NAME_____

ADDRESS_____

CITY_____ ZONE_____

COUNTY_____ STATE_____

For more data circle this page number on card at back of book

Washing Machine Supply-Drain

A line of recessed cabinets containing supply valves and drain connection for automatic clotheswasher

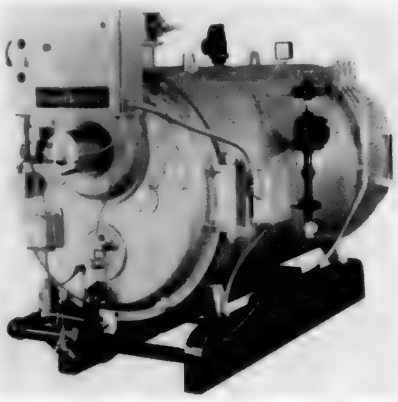
hookup is available from Guy Gray Mfg. Co., Paducah, Ky. Flush mounting in wall saves space and permits concealing piping within wall, the company points out.

Available with or without electric outlets, units are approved by the Western Plumbing Officials Association, Underwriters Laboratories, and are said to meet all plumbing codes when properly vented.

More Information? Circle Item 74 on Inquiry Card.

Simplified Boiler

A packaged boiler, combining operational simplicity with fully automatic controls, is announced by Cleaver-Brooks Co., Milwaukee, Wis.



The fire tube boiler, designated CBH, was developed because of the increased use of gas as a primary fuel for boilers of 50-100 hp. Available from 25-100 horsepower, it is available in models that can be fired by gas, No. 2 oil, or a combination of gas and light oil. It can be used for steam, 15-250 psi, or hot water systems.

Since CBH models operate on gas or light oil, they do not require the air atomizing equipment that the company provides with its CB series for burning heavy oil. This made it possible for the company to simplify the design and operation, and still retain the high efficiency and quality features of the CB line.

More Information? Circle Item 75 on Inquiry Card.

3 good reasons for specifying the NEW Fairbanks Morse SPLIT CASE PUMP

1

CASING WEARING RINGS:

Maintain high pump efficiency, minimize recirculation past the impeller rim; rings easily replaced when waterborne particles cause wear.

2

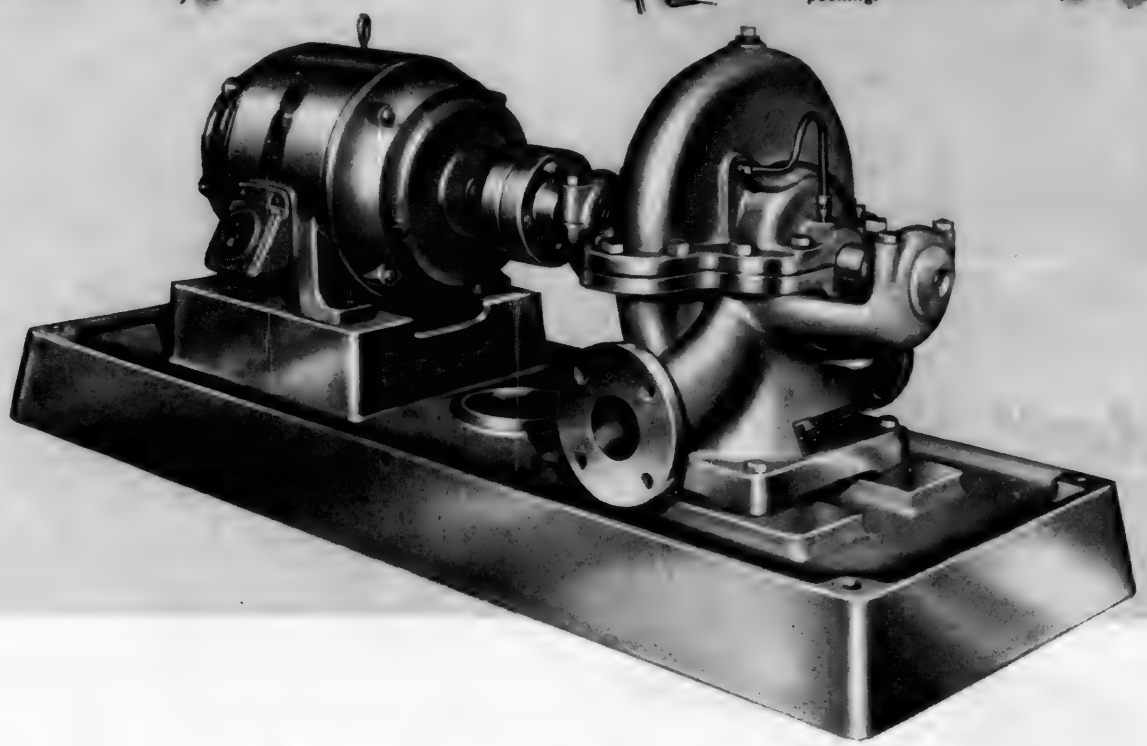
MAINTENANCE-FREE OPERATION:

Sealed pre-lubricated bearings require no checking, no lubrication service.

3

SHAFT SEALS OR PACKING:

Optional construction, factory supplied or field conversion, to suit pumping requirements, either mechanical shaft seals or conventional ring-type packing.



A brand new design . . . a brand new simplified concept in Split-Case Pumps. By far, your best buy. Single stage, horizontal Split-Case Centrifugal Pumps—a wise choice for chilled water, circulating or booster duty —cooling towers or general water supply, designed and supplied to you at moderate cost. For further information and factual bulletin #5820, write: **Pump & Hydraulic Div.; Fairbanks, Morse & Co.; Kansas City, Kan.**

FAIRBANKS MORSE

A MAJOR INDUSTRIAL COMPONENT OF

FAIRBANKS WHITNEY

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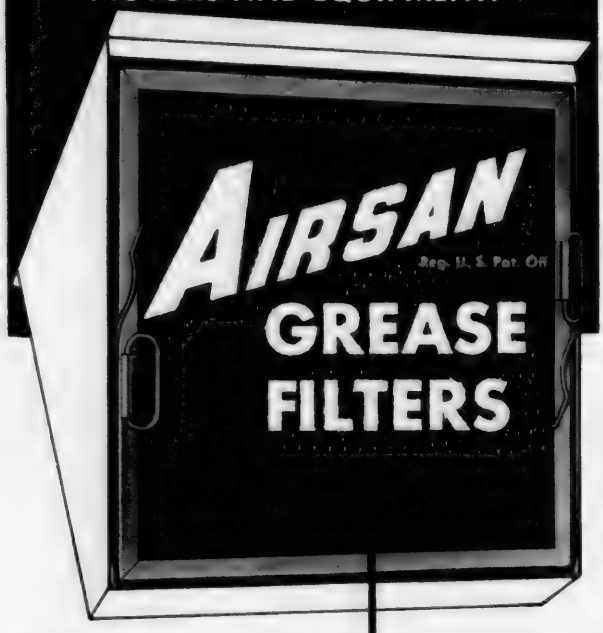
Reduce FIRE Hazards

PROLONG THE LIFE OF FANS, MOTORS AND EQUIPMENT!



• **PERMANENT, CLEANABLE TYPE AG**
Made especially for range canopies, galleys, kitchens, ventilation systems.

• **EXTRA HEAVY CONSTRUCTION**
Provides better thermal mass to resist "burn-outs." To offer longer service, also available in stainless steel enclosing frames.

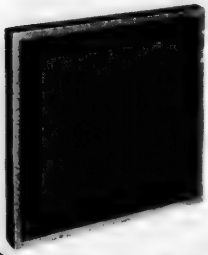
• **PRE-ASSEMBLED UNITS for CEILING or WALLS**
Completely pre-assembled units available . . . just set in place and bolt together. Save time and labor costs. Eliminates complex assembly problems. Available in stainless steel, steel, aluminum.

Prevents grease from entering exhaust ducts, protects motors, increases working comfort to provide safe kitchens for Industrial Plants, Hospitals, Hotels, Etc. Write for bulletin G505.

AIRSAN AIR FILTERS...

give you better filtering efficiency because they're engineered to your needs. Write for details.

AIR FILTERS (Low Velocity) Type AF
Viscous impingement type, permanent and cleanable — designed for industrial, commercial and domestic use. Available in 1" and 2" thickness. Bulletin No. 302.



VIRO-CRIMP (High Velocity) Type W
Has a specially designed high velocity Viro-Crimp Filter media. Hemmed edges provide a safety feature. Operates efficiently at 300 to 600 fpm. Available in 2" and 4" thickness. Bulletin No. W-903.

SEND FOR FREE BULLETINS!

Air Filter Corporation

A few distributorships available. Write for details!
4654-S West Woolworth Ave., Milwaukee 18, Wis.
Canadian Representative: Douglas Engineering Co., Ltd., Toronto

For more data circle this page number on card at back of book

Test Kit for Hermetic Burnout

A field test kit to determine degree of acidity in burned out hermetic systems, and a new, simplified

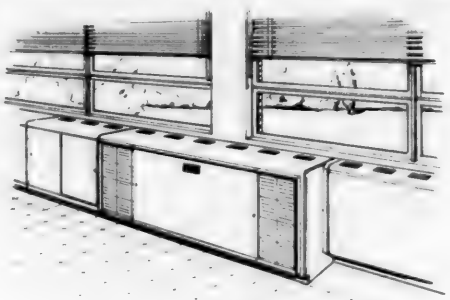
way to clean out mildly contaminated systems, is announced by General Chemical Div., Allied Chemical Corp., New York, N. Y.

Until now, the company says, there was no quick way to determine degree of acidity in a system after burnout and no easy way to tell when the acid had been cleaned out. The kit is designed to take the guesswork out of hermetic burnouts, one of the most difficult service problems in the refrigeration and air conditioning industry. The field test shows the extent of burnout contamination, what clean-up procedure to use, and when cleaning is complete.

More Information? Circle Item 76 on Inquiry Card.

Hydronic Classroom Ventilator

Introduction of its DVW3-1280 all-season classroom ventilator is announced by Lennox Industries Inc., Marshalltown, Iowa. Unit is said to offer the



advantages of the Lennox Comfort Curtain air distribution system to the field of hydronics. The unit is specifically designed for use with the primary-secondary pumping principle of water zone control.

According to the manufacturer, the primary-secondary pumping system permits a degree of control which control valves alone do not afford and permits a high system temperature drop, yet maintaining efficient water flow in the zoned coils. The obvious advantages are heated or chilled water flow in the zones only on demand, for optimum system efficiency, and a drastic reduction in pump and pipe sizing.

More Information? Circle Item 77 on Inquiry Card.

The Diplomat, completed in 1959, offers a long list of unusual comforts and fine appointments. Architect: A. H. Salkowitz; Engineer: Charles Wurmfeld; Conveniences embodying the finest in architectural design, construction. Builder: Irving Warfield. Heating Contractor: Par Plumbing Company.

LUXURY APARTMENTS SECURE YEAR-ROUND HEATING COMFORT WITH EASILY INSTALLED WEATHER-COMPENSATING SARCOTHERM HEATING CONTROL SYSTEM

This is the Diplomat, a prestige address in Long Island's Forest Hills. Its Sarcotherm Weather-Compensating Heating Control System provides tenants with comfortable temperatures throughout the heating season, regardless of outside weather. In projects like this, perfection must extend to every area of living comfort, and Sarcotherm systems assure the necessary accuracy and reliability, *with no installation problems.*

Precisely calculated valve orifices, with plates brazed in at the factory, insure proper distribution of sub atmospheric steam, even in mild weather. Sarcotherm Continuous Flow Modulating Steam Control Valves, factory-calibrated, meter steam to provide proper heat by reacting not only to outside temperatures, but to changes in wind velocity and solar radiation. The complete programming operation is handled by a Master Control Panel which automatically regulates cycles for daytime and nighttime operation and quick morning heat-up.

The Diplomat control system was easy to install rapidly, for several good reasons. Sarcotherm supplied custom-made detailed drawings, tagged every component, and keyed every part to the drawings. Sarcotherm engineers provided supervision throughout the job and made final system adjustment through start-up.

When you call in Sarcotherm on any major heating control problem, you get a custom-planned solution based on wide ranging experience. Sarcotherm takes undivided responsibility for quality components integrated into a reliable control system. It will pay you to deal with Sarcotherm. First step: Write for complete literature. 5790

FOR COMPLETE CONTROL SYSTEM CATALOG write Sarcotherm Controls, Inc., 635 Madison Avenue, New York 22, N.Y.

SARCOTHERM

SARCOTHERM-CONTROLS, INC.,
AN AFFILIATE OF SARCO COMPANY, INC.,
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

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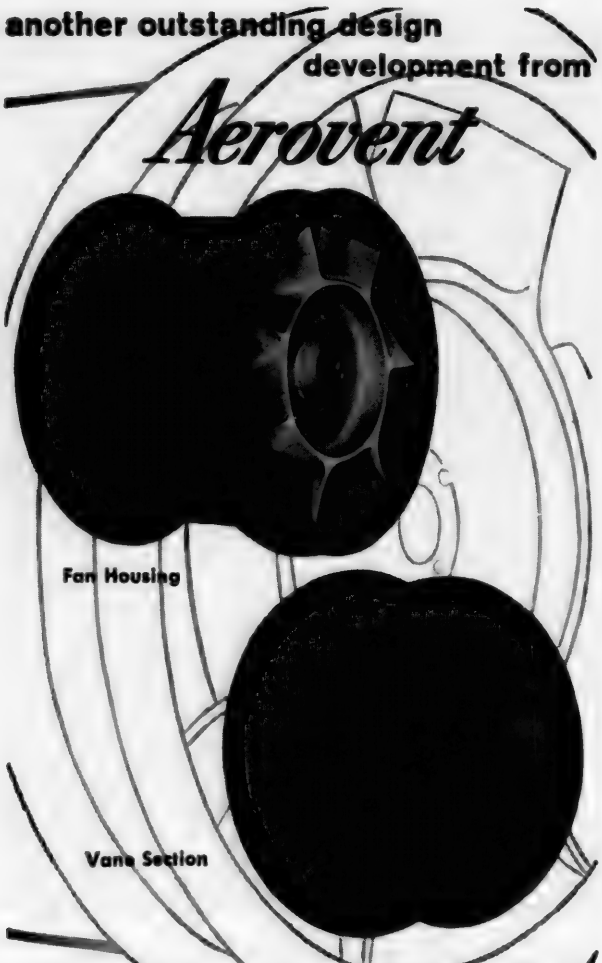
another outstanding design development from

Aerovent



direct-connected
vaneaxial
fans
with removable vane sections

Engineered for high-pressure, high-velocity air distribution systems, these units feature a unique removable vane section which simplifies installation and permits easy access for routine cleaning and maintenance.

Available in 30 models in sizes 18" to 48" for capacities from 3230 to 67,300 cfm with special design features for all application requirements.

Write for Bulletin 475

Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

CERTIFIED PERFORMANCE

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FAN COMPANY, INC.
ASH AND BRANDT STREETS PIQUA, OHIO

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Sequence Controller

The Master Monitor, offered by Cleveland Controls, Inc., Cleveland, Ohio, is said to be a new concept in sequence control of multiple boiler installations. It is a complete modulating and sequence control system in a single, compact enclosure, for automatically operating a bank of boilers, compressors or other units, so that only the required number are called on to meet the load demand.

Unit cuts individual units in and out of operation in response to pre-determined pressure or temperature variations, or to any other signal. The lead unit is selectable at any time by simply turning an externally accessible rotary switch. Lag units always follow in numerical sequence. The lead unit may be changed as often as required.

The Master Monitor is adaptable to modulating, high or low, or on-off systems. One model is designed for use with boilers equipped with Honeywell Modutrol motors. Another is designed for use with Cleveland Controls actuators. Others can be used for simple line voltage switching. Models are available for sequencing up to ten units. All can be applied to existing installations as well as to new construction, with a minimum of field wiring and set-up time.

More Information? Circle Item 78 on Inquiry Card.

Metal-to-Metal Faucet Control

Met-L-Pak cartridge type faucet control uses no washers, packing or threads, yet provides total, friction-free shut-off, according to its manufacturer, Universal-Rundle Corp., New Castle, Pa. Permanent, precision-honed and matched plates are said to deliver the longest maintenance-free service yet.

Unconditionally guaranteed for five years, the new control is fully tested and operates smoothly and efficiently under any water pressure. A unique roll-pin stop assures the handles will shut off in the same position every time. This completely sealed unit is available as optional equipment for all Universal-Rundle Luxury Trim plumbing fittings .

More Information? Circle Item 79 on Inquiry Card.

North Birmingham School has

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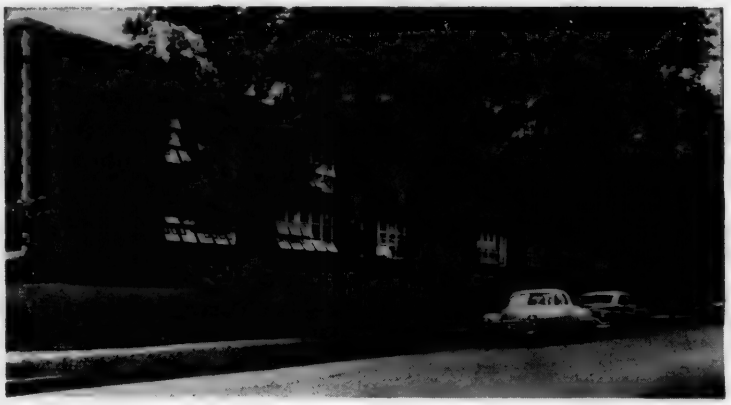


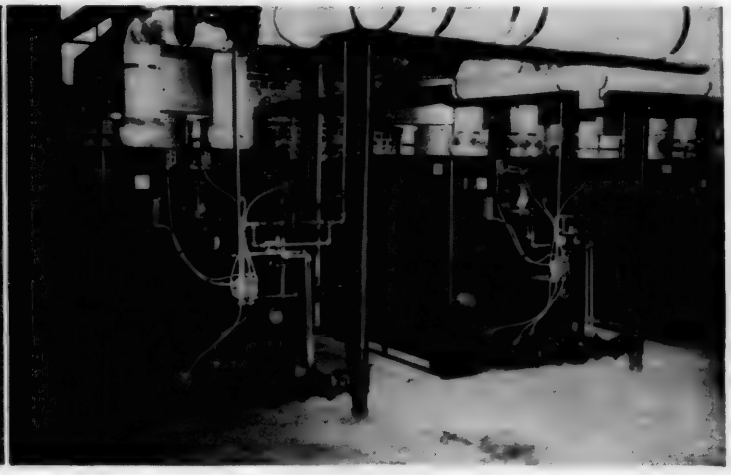
with Bryan Steam Boiler System

The 675 pupils and their teachers in this 20 room elementary school stay comfortable, even during rapid changes in the temperature outside, because heat load changes are handled automatically with the three gas-fired Bryan Steam Boilers.

As long as one boiler carries the load, the other two do not operate, but as soon as more steam is required, the controls in this parallel system automatically turn on the additional boiler(s) needed. Each pressure control is set a little higher than the previous one to give "step control". These 2,000,000 BTU No. 522-S Bryan Steam Boilers are equipped with hi-lo two stage burner controls to complete the flexibility.

Bryan Steam Boilers provide *Economy* in boiler room space . . . *Efficiency* in operation . . . Minimum in maintenance. Write for engineers specifications, available on Bryan Boilers to fit every type installation.

Bryan
COPPER TUBE
Boilers



Bryan Copper Tube Boilers are designed and built to the requirements of the A.S.M.E. Code. Gas-Fired models A.G.A. approved.

BRYAN STEAM CORPORATION • Peru, Indiana

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WHITE ROOMS

(Continued from page 12)

Now we have the basic ingredients for the system, temperature, humidity, cleanliness, and pressure control. How were they combined into a functioning entity? Calculations by the engineers indicated that only a portion of the return air need be dried; therefore, only 30,000 cfm of return air was removed to the drying equipment. Here this air was combined with 15,000 cfm of filtered fresh air. The total 45,000 cfm of dry, clean air was pumped to the 48 air-handling units for mixing with other return air before treatment and delivery to the area. The air-handling units had been sized to allow approximately one-half change of air in excess for room pressurization. This was above allowances for leakage and exhaust processes.

Employees Issued Bulletins

The most important portion of the project involved the education and cooperation of the hundreds of employees who worked in the area. Four air locks of approximately 1200 square feet each were provided as the only entry points into the room. Lockers were provided in these air locks for personal belongings and coats. A non-linting smock was supplied to each female employee and a fingertip length coat of the same material was furnished to the male employees. No restrictions were placed on cosmetics for women or after-shave powder for men. The entire area was designated as non-smoking. No real restrictions were placed on the clothing or type of shoes worn under the garments furnished the employees.

Long mats were placed up to and inside the airlocks to provide a rough surface to remove loose dust from shoes. A central vacuum system was installed with approximately 25 openings, any 10 of which could be operated simultaneously. A series of educational bulletins was supplied each employee concerning use of the room and how to maintain cleanliness standards. The janitorial force was instructed carefully in how to clean the area without increasing the humidity or dust count. The vacuum system was used for light dust removal and a rather dry damp mop was used to remove stains and chemical spillages. Each work station was made the responsibility of the person assigned to work there. Only on week-ends were the janitor crews allowed to scrub, mop, and rewax the floors. Buffing with large machines was held to a bare minimum and usually was done by equipment having vacuum attachments. A hard surface, a plastic-base wax, was used to seal the tile floor and reduce dusting.

Results: Area No. 1

A constant monitoring of temperatures and relative humidity was taken with recording devices. Dust counts were made with the conventional "swatch" test methods. As a result of this project, some very interesting facts were revealed.

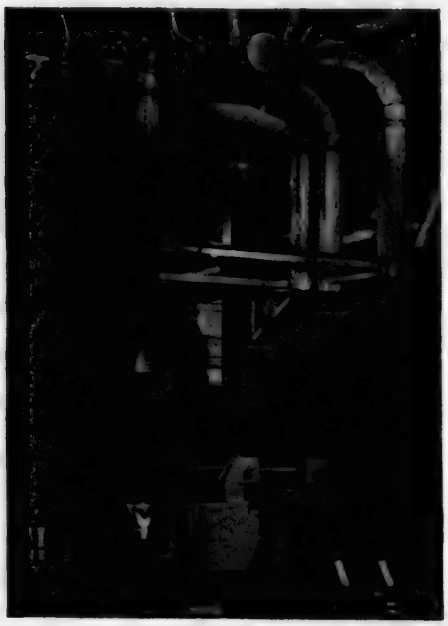
1. The cost to construct and maintain such a program is rather high and monetary returns in the semi-conductor business that can be attributed directly to this project are very difficult to determine.

2. Due to necessity of access by several thousand persons, borne dust and contaminants were found to be almost impossible to control.

3. Due to inherent design problems in the drying equipment, some significant amounts of chemical carry-over were found. This seemed to be a sporodic but discoverable incident during various tests.

4. Types of paints to be used on work furniture, process equipment, and building interiors must be carefully selected to reduce dusting and dust-attraction problems. It was found that some plastic paints could establish a static charge or air-borne dust due to velocity and volume of the

YOU SAVE MORE WITH FLEXAUST® HOSE



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Bubbles make Buensod's new, improved air mixing valve stronger . . . 23,000,000* bubbles stronger. Research has led us to fill these new valves with polyurethane foam. The result is a better insulated valve with improved acoustical characteristics and far greater structural strength. And although the quality has gone up, the price hasn't.

This improvement is typical of the way Buensod-Stacey does business . . . always planning for a better product. The company that pioneered and developed Dual-Duct high velocity air conditioning has never stopped refining this advanced method of year 'round conditioning. There's a place for Dual-Duct in your next project, whether new structure or renovation. Your local Buensod rep will be glad to help. Call him.

*Approximate number of polyurethane foam cells found in the air mixing valve of Buensod-Stacey Type V under-window unit.

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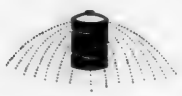

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Just a touch of the toe serves clean, tempered water. There are no germ-laden faucets to fuss with — hands touch only the clean spray. Duos are self-rinsing, too.

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One Duo can do the work of two conventional basins — yet requires only one set of plumbing connections! This feature saves money, valuable space, and water.

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Users appreciate Duos. So do maintenance men, since the Duo's foot pedal swings up and out of the way for easy floor cleaning. A removable front panel makes them very easy to service, too.

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Trim, contemporary Duos are available in stainless steel and in six vitreous enamel colors. A stainless steel Duo with integral back panel also is available.

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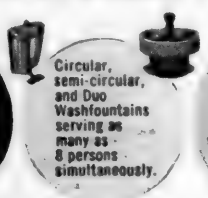
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61-114-R1

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WHITE ROOMS

(Continued from page 120)

passing air; at least, certain surfaces had more tendency to attract dust than other surfaces in the same general area.

5. The selection of process equipment must be reviewed carefully to avoid air-conditioning and cleaning problems. For instance, some furnaces not as well insulated as should be, cause localized hot spots which require extensive rebalancing of air flows or considerable reinsulation. Rebalancing the air flows would at times cause excessive velocities across filters of some air-handling units and hinder their efficiency.

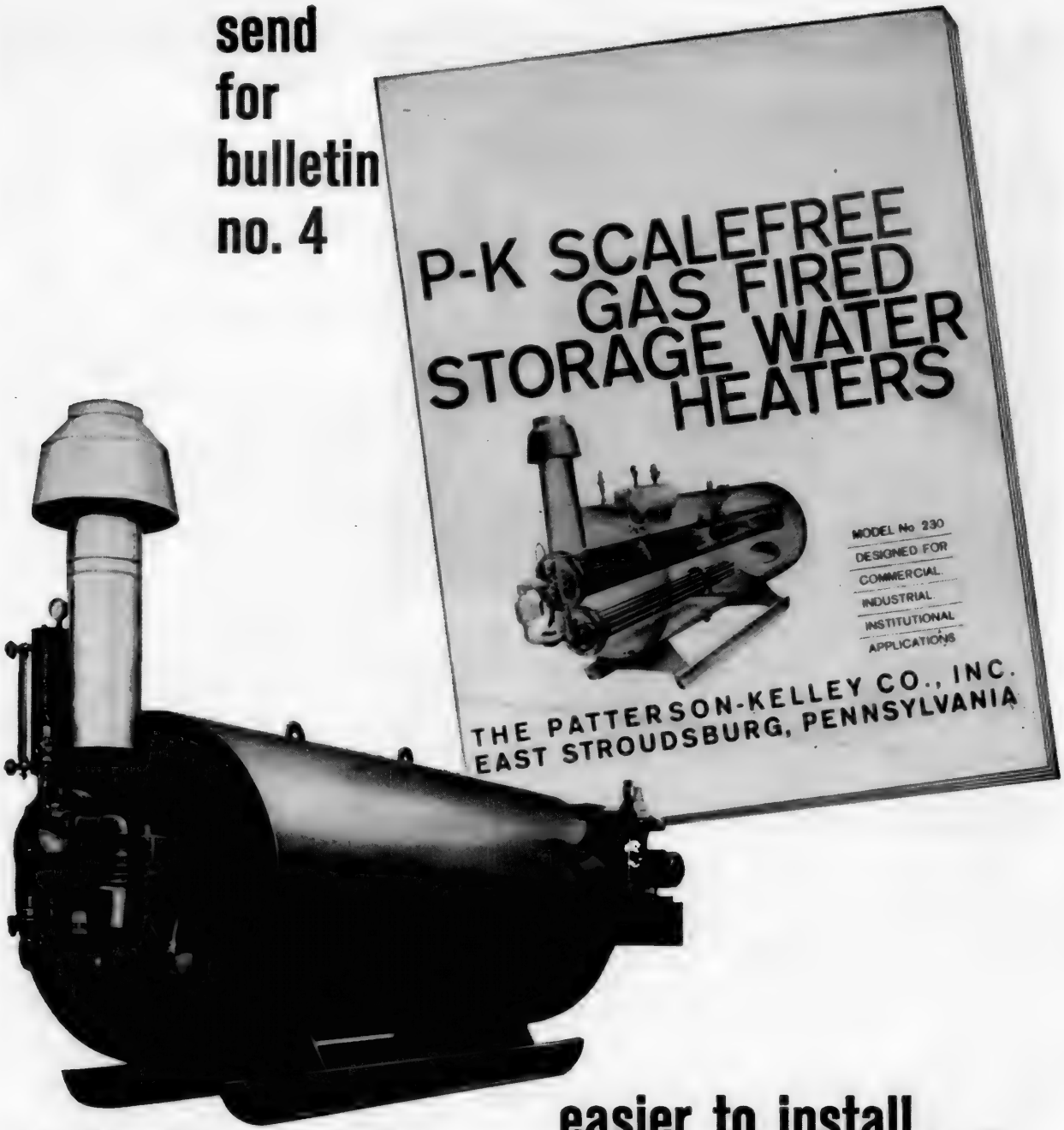
6. When the humidity was maintained at 30%rh or less, there were many more complaints that the temperature was too low. There also appeared to be more minor head and nasal ailments occurring. Visits to First Aid were reduced by a factor of 2 when humidity was raised to and maintained at about 50%. Consequently, the control of the human element by ingress and egress through the area was more difficult, partially due to lower humidities and cleaner air. No real survey was made to verify this other than monitoring the reasons for and quantity of first-aid visits.

7. Monitoring the area for all conditions was expensive if done accurately. Balancing the effects of conditions in one area to an adjacent or even remote area caused considerable changing of input air loads, temperature changes, direction of air flows, and filter banks. The task was not impossible, but was time-consuming and more expensive than desired.

8. Business expanded very rapidly with manufacturing requirement resulting in creating more humidity and dust-inducing processes than the capabilities of the equipment could overcome. For instance, removing hydrogen-gas furnace operations by burning with a hydrocarbon gas naturally

(Continued on page 124)

send for bulletin no. 4



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Address your request to: The Patterson Kelley Co., Inc., 25 Morgan Avenue, East Stroudsburg, Pennsylvania.

Patterson Kelley
Water Heater Division

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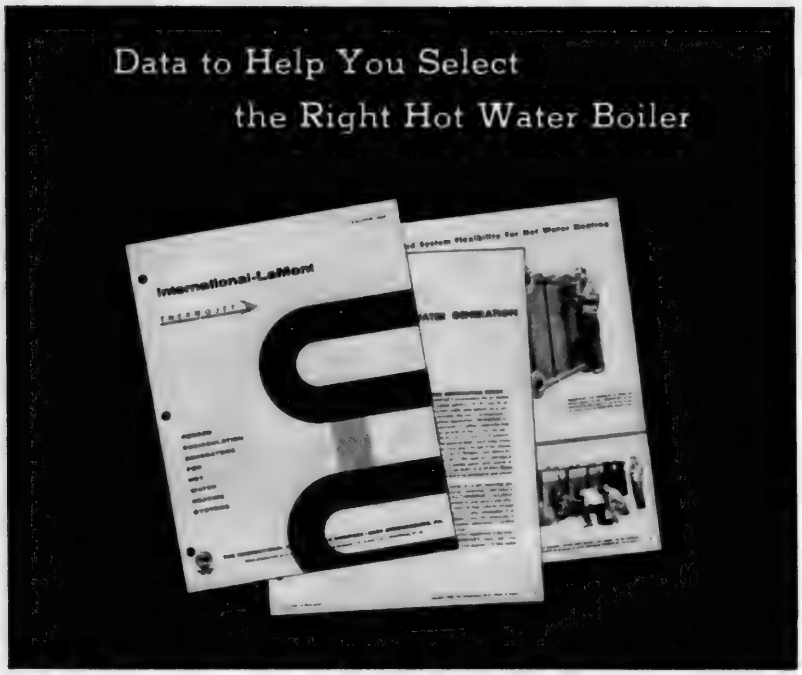

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WHITE ROOMS

(Continued from page 122)

increased the moisture, as well as carbon monoxide and dioxide, content of the atmosphere.

9. Again, due to the startling expansion of business, the condition of positive pressure was virtually impossible to maintain. Safety precautions involving removal of toxic fumes generated as a direct result of process changes and expansion required a more rapid increase in air removal than could be supplied through the drying and cleaning equipment.

Although the previous statements would lead one to believe that the project was a complete failure, it was adequately successful in that it proved several points. *First*, in our business, the overall area must be clean and be furnished with filtered air (and our means of filtering was sound.) *Second*, many processes previously thought to require clinical cleanliness and humidity control did not need this close attention while several others required stricter attention and had more rigid condition requirements. This type process could be and is handled on an individual or small-group basis. *Third*, the procedures developed for the housekeeping crews were good and can aid in controlling airborne contaminants. *Fourth*, the employees became more dirt-conscious and developed better work habits to aid in controlling this condition. At this time, we have relaxed the humidity control requirements to a normal 50% rh, but are maintaining the filtration of incoming air as before. Each process that requires highly critical conditions is treated individually, usually with a specially designed cleaning and drying system for ultra-clean work. This system will be described a bit later.

Area No. 2 Is Smaller

The second approach to white rooms involves a laboratory designed to house experiments con-

(Continued on page 126)

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"Many of my air conditioning and refrigeration systems have to operate 12 months a year. But cold weather used to raise cain with compressor-condenser balance.

"Then I learned that Halstead & Mitchell had a Limitrol pressure modulating valve that adjusts their air-cooled condenser capacity to compressor head pressure, whatever the outside temperature. What's more, H&M gives me multiple circuiting at no extra cost!"

You'd do well, too, to standardize on H&M Air-Cooled Condensers. There are propeller fan models with vertical or horizontal air discharge, and centrifugal fan models for inside installation with ductwork. Capacities of 5 to 100 tons.

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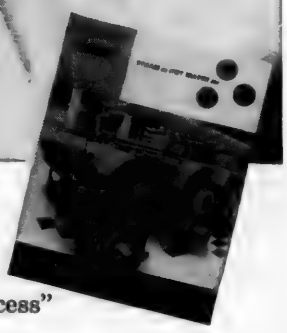

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WHITE ROOMS

(Continued from page 124)

cerning surface treatment of semi-conductor devices. The laboratory is small, enclosing only 600 square feet of space with a cubage of 5000 cubic feet. Therefore, the problem is much simpler. The main objective was to create a controlled reproducible condition.

The laboratory is divided into two rooms. The primary difference in the two is that one is maintained as the "cleanest" room, which I will call Room *A*. This is achieved by being more restrictive in its use and by requiring that anyone entering change into special, lint-free clothing from the skin out. This includes wearing a head covering and special shoes. By contrast, to enter the other room, or Room *B*, one is only required to wear lint-free coveralls over street clothing, special shoes, and head covering. Room *B* is entered through a small air lock for changing clothes and it contains a laboratory and an electric hand dryer. Contained in each room are stainless steel dry boxes with even finer filtering and humidity controlled atmospheres than the rooms. In fact, the room humidity is not controlled other than through normal air-handling and cooling equipment.

The room air and dry-box air systems will be described briefly. Pretreated plant fresh air is received and mixed with return air, then filtered through fiberglass media. It then is passed through an electrostatic precipitator. The precipitator is a semi-automatic device whereby the cleaning must be started manually, but the remainder of the cycle is automatically programmed. This is to avoid a wet cleaning during the course of an experiment being conducted within the lab. The air then moves through a low-pressure charcoal filter to remove organic vapors. A special 5-ton, 2500 cfm air-handling unit then receives the air for heating or cooling. Next, the air passes

(Continued on page 128)

please

Men in white clean and sterilize Adsco Expansion Joints with steam and detergents, dry, and hermetically seal them in polyethylene bags. At an Air Force Titan missile base, system contamination is less than 25 parts per million, with no particle larger than 150 microns.

Cleanliness of this magnitude reveals the slightest imperfection. The construction of these expansion joints which glisten like diamonds is revealed as not just good, but perfect; one slip could bring disaster.

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WHITE ROOMS

(Continued from page 126)

through a high-efficiency filter to remove dust particles down to 0.3 microns. From there, the air moves in two directions: in one, it goes to the laboratory room, and in the other, it furnishes exhaust air to a toxic-fume hood. The air system is designed to maintain a positive pressure in each room. The pressure in Room *A* is higher than the pressure in Room *B*, which in turn is slightly higher than pressure in the air lock. All rooms are of higher pressure than surrounding area. Pressures are monitored continuously by permanently installed manometers mounted outside the rooms.

How Ultra-Dry Air System Works

The ultra-dry air system used in dry box operations is as follows: The regular plant dry air used at many work stations throughout the plant is the input air to this system. The plant air has been compressed to 100 PSI with oil-less compressors passed through two stages of aftercoolers using 40 deg water, then through desiccant dryers and through a high-pressure, inline filter to remove dust and chemical particles down to the 10 - 15 micron range. Such air, as previously noted, becomes the input air to the ultra-clean dry-box system. The air passes through five additional cleaning and drying stages: (1) a charcoal filter to remove organic vapors, (2) 10-micron filter, (3) 5-micron filter, (4) molecular sieve for drying and removing carbon dioxide, and (5) a high-efficiency filter to remove particles down to 0.3 micron. The output air has a dew point of —100 deg.

To assure the super-clean condition desired, the following determinations are made as a regular routine: 1. dust counts in critical area, 2. air and charcoal analysis, 3. moisture analysis in dry box, 4. air and charcoal analysis in dry box.

All equipment in the room was

(Continued on page 130)

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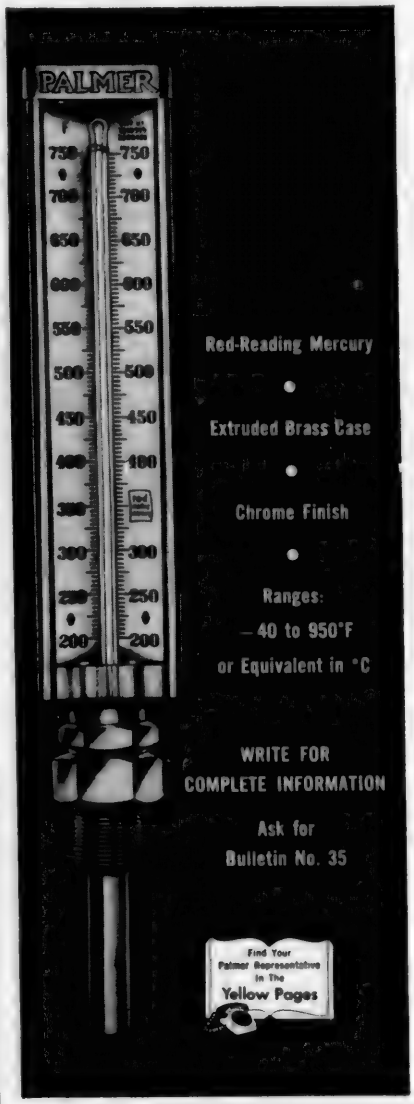

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EASY TO SIZE
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153 N. Grove Ave., Elgin, Illinois
Representatives in Principal Cities
In Canada: G. F. Sterne & Sons, Ltd., Brantford

For more data circle item 130A

WHITE ROOMS

(Continued from page 128)

sealed carefully, all walls treated with good plastic-base paint, all piping, ductwork, etc., entering the room sealed by welded connections and *O* ring gaskets through specially designed brackets. Light switches, telephone jacks, light fixtures, etc., are specially designed dust- and vapor-free devices. The flooring is sheet vinyl with a special cove designed to seal corners and sides. The ceiling is of baked-on enamel board (Texa-board). All input and return air grills enter through the ceiling and are sealed with rubber and plastic caulking compound from the inside. A very careful and thorough job was done to insure that the rooms were properly sealed, all materials clean, and supply systems adequate.

After the initial scrub-down, dust counts indicated the rooms were 500 times cleaner than the surrounding area. In fact, the count was so low as to be almost impossible to establish accurately. All cleaning of rooms, if any, is done by hand with a chamois and a vacuum system. Employees have been very carefully instructed as to their cleanliness, use of equipment, and housekeeping methods. To be absolutely truthful, only two or three employees have been trained and are authorized to enter the area.

Conclusions Detailed

This experience has resulted in several principles for assuring room cleanliness. These have been listed as (1) Restrict the access of humans to and from; (2) provide adequate tools for housekeeping; (3) provide lint-free clothing and coverings; (4) use air locks and pass-throughs for all egress and ingress; (5) put air traps on all exhaust systems; (6) establish routine monitoring techniques; (7) provide voluminous instructions and employee educational data; and (8) provide internal, positive air pressures.

(Continued on page 132)

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HIGH CAPACITY **8600 GPH** at
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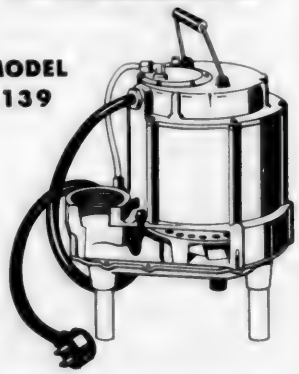

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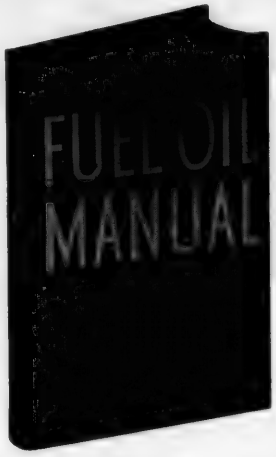

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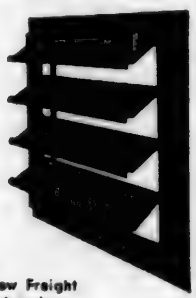

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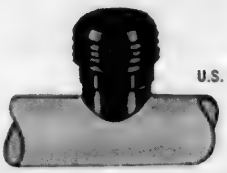

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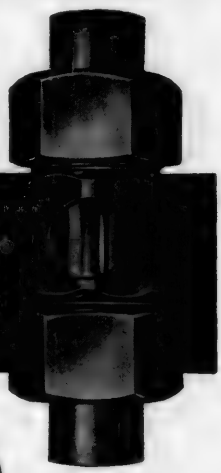

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WHITE ROOMS

(Continued from page 130)

The preceding rather lengthy and detailed discussion of both approaches to "white" rooms was designed to present two almost opposite purposes for having such working areas. On the one hand, a very large area, and, on the other, a very small and isolated confinement. Yet both approaches have the inherent basic problem in that human beings were required to perform their work habits within the confines of the treated room. All tests and surveys proved conclusively that mechanically, a room or space can be made much cleaner than you can measure and can be maintained in the same way until the human factor is introduced. At such time, either extensive and detailed instructions must be employed concerning everything, from work habits to personal sanitation, or the battle is lost. Great volumes of clean air do not necessarily mean clean space; it could mean a vigorous agitation of existing dust particles and possibly the creation of more air-erosion problems. Our theory now is to keep the air volume low and the people out, and the chances of success are great.

AIR CLEANING INSTITUTE AT HARVARD IN JUNE

Harvard University School of Public Health is conducting an intensive course on air cleaning. The course consists of lectures and laboratory sessions which have been designed to provide graduate level training in theoretical and applied aspects of air and gas cleaning procedures and equipment, the School announced.

Topically, the course will include: Basic Theories and Principles of Aerosol and Gas Collection; Stack Sampling Methods and Data Evaluation; and Performance of Typical Air & Gas Cleaners. For further information, write to Leslie Silverman, Sc.D., Harvard School of Public Health, 55 Shattuck St., Boston 15, Mass.

BRIEFLY STATED

Koegel & Haggard, consulting electrical engineers, Dallas, and Gerard M. Baker, consulting mechanical engineer, San Antonio, announce the formation of a new partnership under the firm name of KOEGEL, BAKER AND HAGGARD, consulting mechanical and electrical engineers, 1808-B Sylvan Drive, Dallas 8, Texas. . .

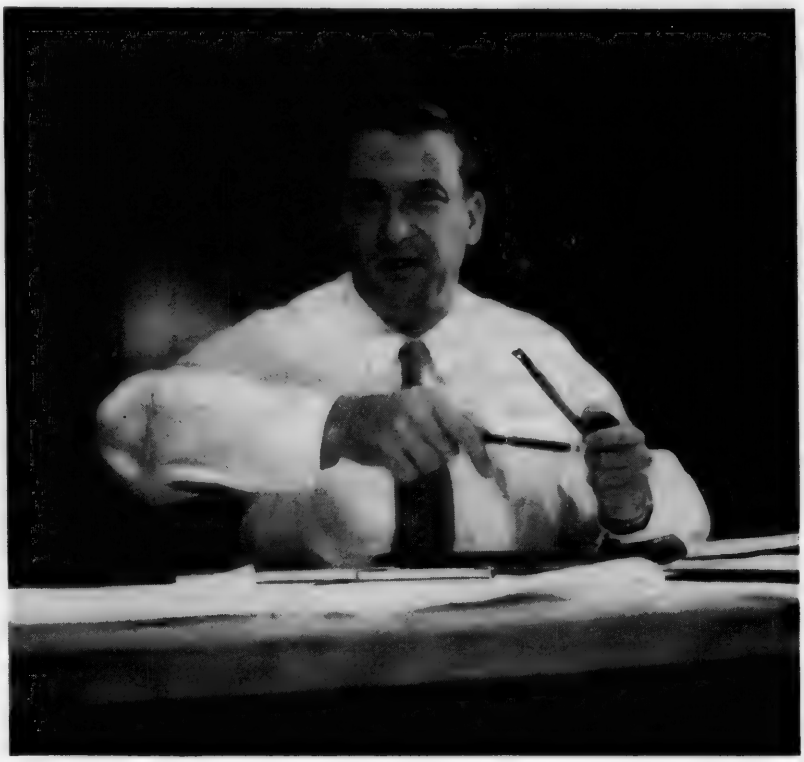
Wilfred W. Aronwits has joined the staff of the J & G DAVERMAN COMPANY, Engineers, architects and planners, in Grand Rapids, Michigan, and has been named chief of this firm's mechanical, engineering department. Mr. Aronwits, a registered professional engineer, was formerly director of mechanical engineering for Smith, Hinchman and Grylls. During his 13 years with the Detroit firm, he directed the mechanical engineering work on such major projects as these: General Motors Technical Center; Atomic Energy plants in Kentucky and Ohio; Wayne University Medical Building; Detroit's Blue Cross Medical Building and Wayne Community Hospitals. . .

Appointment of Jack A. Hallinan as director of engineering for the Kewanee (Illinois) Plant has been announced by AMERICAN-STANDARD INDUSTRIAL DIVISION, Detroit, Michigan. Mr. Hallinan was head of the research and development laboratory at the Kewanee Boiler Plant for more than two years.

Miss Grace Herbst, who was in charge of editorial production for this magazine for the past twenty years, succumbed to a heart attack February 13. This followed a serious lung infection from which she had only recently recovered.

Miss Herbst, who was with The Industrial Press for twenty-five years, will be remembered by her many friends for her extraordinary warmth and helpfulness and by the ACHV staff for the high professional standards which she maintained in her work.

100 percent air recirculation? you're crazy!



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A typical well designed system uses outside air in the spring and fall for cooling and 100% recirculation with activated charcoal purification in the summer and winter. In most buildings normal infiltration and the opening of doors provides plenty of oxygen. Pressurizing of the building can be incorporated if desired. Write for Bulletin T-321. Barnebey-Cheney, Columbus 19, Ohio.

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Canadian Degree-Days for January, 1961*

City	January		Cumulative	
	1961	Normal	1961	Normal
Calgary, Alta.	1207	1530	4691	5190
Charlottetown, P. E. I.	1626	1460	4516	4310
Crescent Valley, B. C.	1152	1360	4441	4580
Edmonton, Alta.	1487	1780	5233	5850
Fort William, Ont.	1886	1830	5719	5790
Grande Prairie, Alta.	1666	1820	5620	6120
Halifax, N. S.	1340	1262	3736	3775
London, Ont.	1457	1320	4210	4000
Medicine Hat, Alta.	1264	1590	4558	5000
Moncton, N. B.	1682	1520	4750	4620
Montreal, P. Q.	1765	1590	4614	4630
North Bay, Ont.	1856	1710	5320	5330
Ottawa, Ont.	1810	1640	4776	4850
Penticton, B. C.	1017	1190	3681	3780
Prince George, B. C.	1385	1570	5072	5330
Quebec, P. Q.	1866	1690	5238	5150
Regina, Sask.	1745	1940	5357	6090
Saint John, N. B.	1629	1440	4618	4570
Saskatoon, Sask.	1769	1990	5768	6240
Timmins, Ont.	2088	1990	6193	6190
Toronto, Ont.	1386	1249	3780	3771
Vancouver, B. C.	749	890	2857	3010
Victoria, B. C.	678	800	2730	2770
Windsor, Ont.	1350	1220	3785	3660
Winnipeg, Man.	1959	1993	5918	6023

* These data are supplied through the courtesy of the Meteorological Division, Air Service Branch, Department of Transport, Canada.

COMING EVENTS

Where listed, names or titles of individuals are those from whom further information is available.

NATIONAL SYMPOSIUM ON TEMPERATURE—Third National Symposium on Temperature—Its Measurement and Control in Science and Industry, sponsored jointly by the American Institute of Physics, Instrument Society of America, and the National Bureau of Standards, to be held in Columbus, Ohio. C. L. Roberson, ISA 313 Sixth Ave., Pittsburgh 22, Pa. ..... **MARCH 27-31, 1961.**

CORROSION ENGINEERS CONFERENCE—Annual Conference and Corrosion Show of the National Association of Corrosion-Engineers, at the Statler Hotel, Buffalo, N. Y. T. Hull, executive secretary of the Association, 1061 M&M Building, Houston 2, Tex. ..... **APRIL 5-7, 1961.**

INDUSTRIAL HYGIENE CONFERENCE—Annual American Industrial Hygiene Conference at the Sheraton-Cadillac Hotel, Detroit, Mich. Publicity chairman, J. D. MacEwen, Wayne State University, 1401 Rivard St., Detroit 7, Mich. ... **APRIL 9-13, 1961.**

CONVENTION ON WELDING—Annual convention of the American Welding Society, The Coliseum, New York, N. Y. For information write, American Welding Society, 33 W. 39th St., New York 18, N. Y. ..... **APRIL 18-20, 1961.**

NATIONAL CONVENTION—The 39th Annual Convention of the Oil Heat Institute of America will be held at the Statler-Hilton Hotel, Washington, D. C. ..... **APRIL 23-27, 1961.**

Coming Events

CONSULTING ENGINEERS COUNCIL—Annual meeting of the Board of Directors of Consulting Engineers Council, at Executive House, Chicago, Ill. Executive Secretary, L. N. Spiller, 326 Reisch Bldg., Springfield, Ill. ..... **MAY 4-6, 1961.**

BRI SPRING CONFERENCES—Building Research Institute Spring Conference, Shoreham Hotel, Washington, D. C. BRI, 2101 Constitution Ave., Washington 25, D. C. ..... **MAY 16-18, 1961.**

DESIGN ENGINEERING CONFERENCE AND SHOW—Design Engineering Show, Cobo Hall, Detroit, Michigan. Exposition management by Clapp and Poliak, Inc., 341 Madison Ave., New York 17, N. Y. ..... **MAY 22-25, 1961.**

NDHA MEETING—Annual meeting of the National District Heating Association, Wentworth-by-the-Sea, Portsmouth, N. H. Secretary, John F. Collins, Jr., 827 N. Euclid Ave., Pittsburgh 6, Pa. ..... **JUNE 12-15, 1961.**

INDUSTRIAL HYGIENE FOUNDATION—The 26th annual meeting of the Industrial Hygiene Foundation of America Inc. will be held at the Mellon Institute, 4400 Fifth Avenue, Pittsburgh 13, Pa. Dr. H. H. Schrenk, Managing Director, 4400 Fifth Avenue, Pittsburgh 13, Pa. ..... **OCTOBER 25-26, 1961.**

NATIONAL WARM AIR—The 48th Annual Convention will be held at the La Salle Hotel, Managing Director, James M. Martin. National Warm Air Heating and Air Conditioning Association, 640 Engineers Building, Cleveland 14, Ohio .... **NOVEMBER 6, 1961.**

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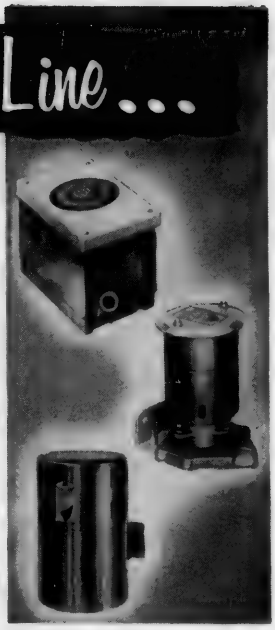

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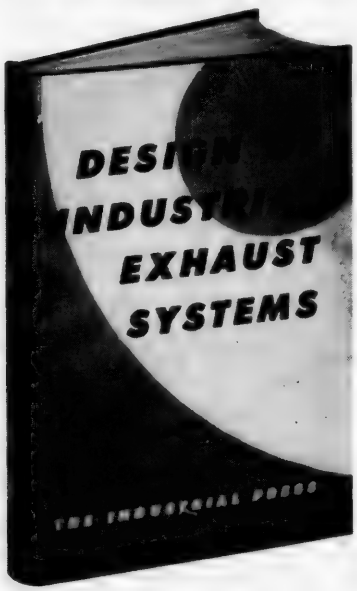

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Coming Events

BRI FALL CONFERENCES—Building Research Institute Spring Conference Shoreham Hotel, Washington, D. C. BRI, 2101 Constitution Ave., Washington 25, D. C. . . . . **NOVEMBER 14-16, 1961.**

ARI EXPOSITION—Air Conditioning and Refrigeration Institute. 12th Exposition. Pan-Pacific Auditorium, Los Angeles. Information: George E. Mills, ARI Show Director, 1346 Connecticut Ave. N.W. Washington 6, D. C. . . . . **FEBRUARY 12-15, 1962.**

PIPING AND PLUMBING

(Concluded from page 91)

hydro-pneumatic tank which serves to absorb any shocks generated in the piping system. However, the engineer should employ shock arrestors in locations where he feels that shocks will originate. The shocks can be destructive to the piping and should be considered when designing a system.

Sectionalized Lawn Sprinkler Systems

The water supply methods described can be used with equal success for single lawn areas as well as for extensive lawns. The smaller areas can be watered at one time whereas the larger areas often have to be watered in sections. With the sectionalized systems, it is extremely important that consideration be given to the longer periods of time that water will be required to handle the different sections. Thus the matter of pumping equipment capacity and water storage must be carefully designed.

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Automatic equipment can be applied to any type of lawn sprinkler system. The equipment will operate the system at regular intervals, any time during the day merely by the proper adjustment of the timing device. Moreover, it can be set to operate on alternate days if so desired. The equipment is flexible and any sequence of operation is possible.

In addition, where a sensing device is placed in the lawn area, the system can be operated automatically depending upon the moisture condition in the ground. When the ground reaches a specific degree of dryness, the device will relay a message back to the control panel to activate the pumping equipment. A typical system is shown in Fig. 8. Here a lawn sprinkler system is used that has been divided into three sections. Electrically operated valves, installed underground, control the supply of water to each section. The soil element device senses the need for water and relays the message to the control center for the activation of the lawn sprinklers. In this case, a timing device will regulate the amount of water to be supplied to each section of the lawn area. As the watering for one section is completed, the water supply is automatically shut off and the next section is activated.

Many types of devices and equipment are available for lawn sprinkler systems. A system that is both decorative and functional can serve the owner with many years of troublefree performance.

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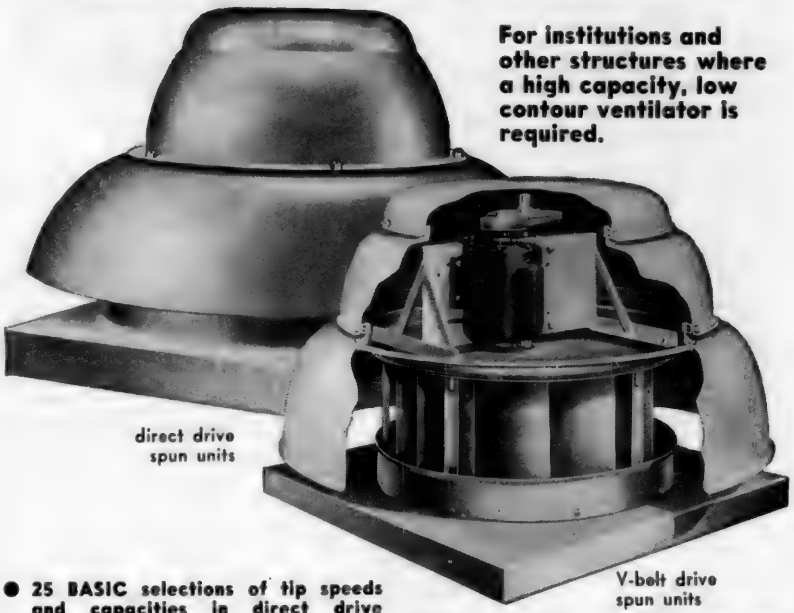

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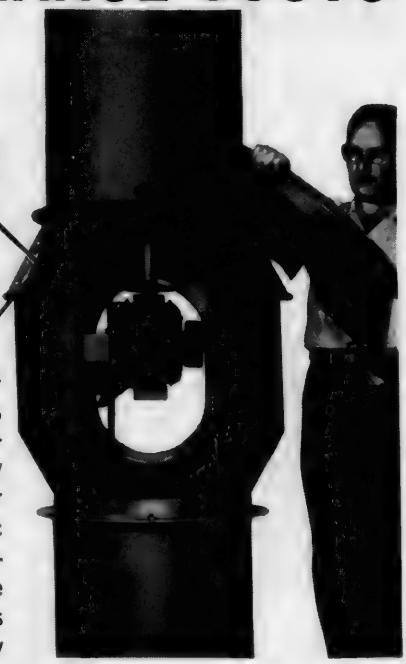

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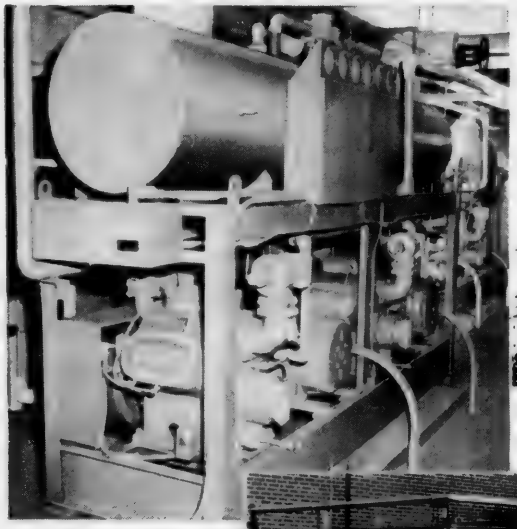
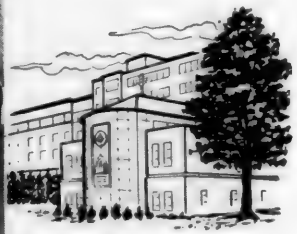
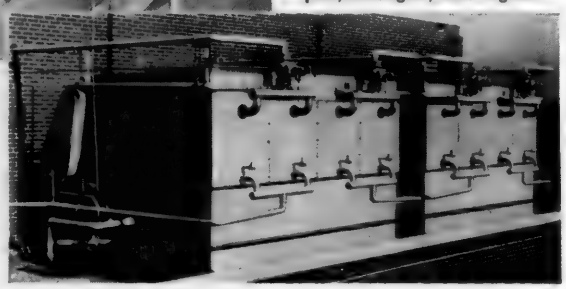


View of the two Vilter packaged water chilling units arranged as four independent refrigeration systems. Two Vilter VMC compressors are included in each chiller unit.



New addition to St. Mary's Hospital, Huntington, West Virginia.



View of the two Vilter evaporative condensers, one for each packaged unit. Each condenser is divided into two separate sections to efficiently reduce capacity when required.

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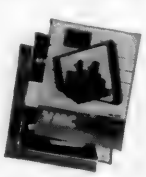

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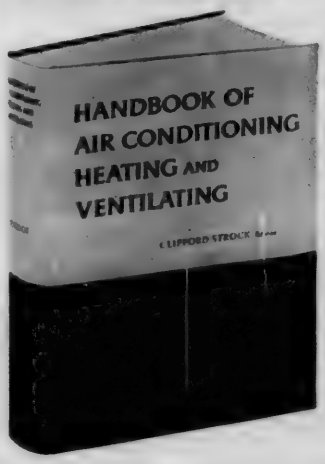

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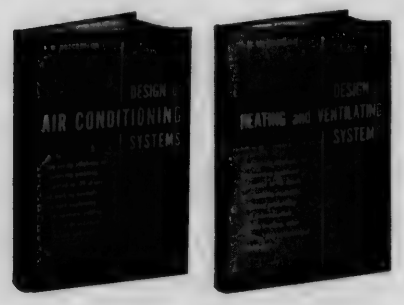

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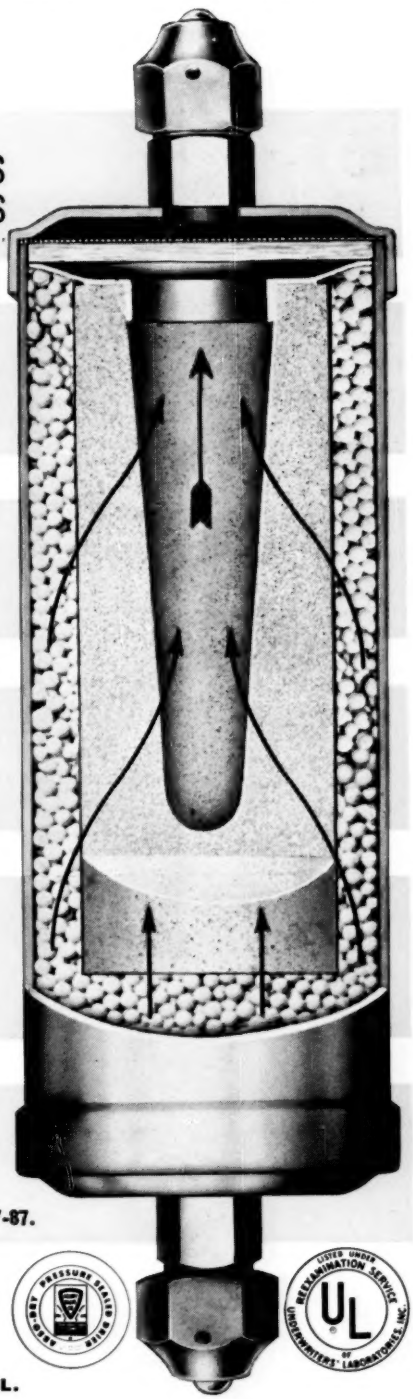

Also Available in Replaceable Cartridge Types . . . Write for DRI-COR bulletin V-87.

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For Refrigeration, Air Conditioning and Industrial Applications

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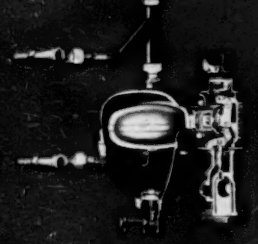
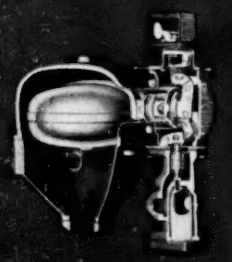
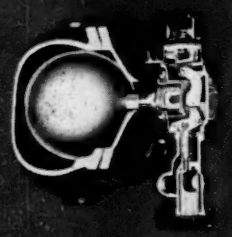


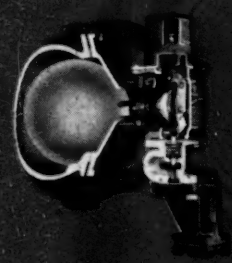
No. 47-2 Feeder Cut-off Combination. The best kind of safety control for the average small steam boiler; maximum pressure, 25 lbs. Has cool feed valve, Quick Hook-up, straight-through blow-off valve and other McDonnell-developed features.



No. 247-2 Feeder Cut-off Combination. Companion to the No. 47-2, developed especially for service on smaller hot water space heating boilers. Maximum pressure, 30 lbs.



No. 51-2 Feeder Cut-off Combination. For larger boilers, both steam and hot water. Maximum pressure, 35 lbs.



No. 53-2 Feeder Cut-off Combination. For higher pressure boilers, up to 75 lbs. Used on both steam and hot water space heating boilers.

The horsepower in your boiler can get thirsty too!

Right from the start, let's get this straight: We're talking about hot water space heating boilers as well as steam heating boilers.

Both kinds can get thirsty. Both can run into a hazardous low water condition from any of a dozen and more reasons.

There's only *one* real answer to the question of a thirsty boiler. That is to install the device that automatically adds water to maintain a safe level in the boiler, then stands by to stop the firing if boiler water drops to a dangerous level.

McDonnell feeder cut-off combinations have been doing just that for many years. They are the best-known, most widely used controls of their kind. Make them a part of every boiler installation.

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